AN ASSESSMENT OF THE EXTENT OF ICT USE ALONG THE DAIRY VALUE CHAIN IN WESTERN UGANDA

MSc THESIS

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SCHOOL OF GRADUATE STUDIES

I hereby certify that I have read and evaluated this Thesis entitled 'An assessment of the Extent of ICT use along the Dairy Value Chain in Western Uganda' prepared under my guidance by Samuel Otaala. I recommend that it be accepted as fulfilling the thesis requirement.

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As a member of the Board of Examiners of the MSc. Thesis Open Defense Examination, I certify that I have read and evaluated the thesis prepared by Samuel Otaala and examined the candidate. I recommend that the Thesis be accepted as fulfilling the Thesis requirement for the degree of Master of Science in Agricultural Information and Communication Management Program.

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BIOGRAPHICAL SKETCH

The author was born in Nairobi, Kenya on 6th January 1984 to Mr. and Mrs. John and Dorothy Otaala. He obtained his Primary Leaving Examination (P.L.E.) Certificate from Joy Primary School, Kampala, Uganda in 1997. He then attended Makerere College School from 1998 to 2003, obtaining both his Uganda Certificate of Education (O-level) and Uganda Advanced Certificate of Education (A-level) from there. Upon leaving there, he was admitted to Makerere University, graduating with a Bachelor of Science in Computer Science in 2008.

He worked with DMark mobile from 2008 to 2010. He then Worked with Infomania Africa Limited from 2011 to 2013. He is currently employed with Hamwe East Africa Limited, a mobile Value Added Services company that aims to provide mobile innovations to grassroots stakeholders.

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I am forever grateful to my family especially my dad and mother to whom I owe my deepest gratitude for being constant sources of strength and hope in every aspect of life despite their humble beginnings. Their continuing support and deep love are the major drive for all my achievements.

ACRONYMS AND ABBREVIATIONS

CNFA	Citizens Network for Foreign Affairs
DFBA	Dairy Farmer Business Association
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GIS	Geographic Information System
ICT	Information and Communications Technology
IICD	International Institute for Communication and Development
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
OLS	Ordinary Least Squares
RCDF	Rural Communications Development Policy
SBO	Service Based Operator
SMS	Short Messaging Service
TAM	Technology Acceptance Model
UBOS	Uganda Bureau of Statistics
UCC	Uganda Communications Commission
UN	United Nations
UNDP	United Nations Development Program
UNICEF	United Nations Children Emergency Fund
USA	United States of America
UTAUT	Unified Theory of Adoption and Use of Technology
VIF	Variance Inflation Factor
WFP	World Food Program

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ABSTRACT

The benefits of ICTs to agriculture have been well documented. Agriculture value chains could benefit from the use of ICTs to increase efficiency and reduce costs, thus reducing risk. By its nature, the dairy value chain is an information intensive value chain in order to preserve the quality of the milk. However, information on the use of ICTs within African communities in general and Uganda in particular is inadequate or nonexistent. The aim of this study was to paint a picture of the information society in Western Uganda as regards the dairy value chain. A cross sectional survey was carried out in Kiruhura district, western Uganda, targeting dairy value chain actors. Three stage purposive and random sampling was carried out in order to come up with 162 respondents, who are actors in the dairy value chain. Data was gathered using pretested interview schedules. The ICTs investigated were Radio, Television, Mobile phones and Computers. It was found that Radio and Mobile phone ownership are the highest, at 50.6% and 64.8% respectively. Radio was mostly used for extension (56.2%) while mobile phones were mostly used for financial services (50%). In the typology of information flows, Coordination of milk products distribution was mostly done by mobile phone (66.7%), Knowledge sharing was mostly done by mobile phone (75.9%), and Feedback from consumers was also mostly done by mobile phone at 85.2%. An Extent of ICT Use index was calculated and assigned to every subject in the sample. The mean Extent of ICT use was 0.32 on a scale from 0.00 to 1.00. Therefore there is a low Extent of ICT use along the dairy value chain in Western Uganda. Ordinary Least-Squares regression was then carried out on the data to examine the relationship between the dependent variable (Extent of ICT Use) and the independent variables. From the OLS regression, it was found that Perceived usefulness, Voluntariness of use, Performance Expectancy, Social Influence, some occupations, and Experience in the 5-10 year range had a significant relationship with the Extent of ICT use along the dairy value chain. Experience in the 5-10 year range had a negative relationship with the dependent variable while some occupations, Voluntariness of use, social influence, performance expectancy and perceived usefulness had positive relationship with the Extent of ICT use.

1. INTRODUCTION

1.1 Background to the Study

Uganda is a landlocked country in East Africa. It is bordered to the east by Kenya, to the north by South Sudan, to the West by the Democratic Republic if the Congo, to the southwest by Rwanda, and to the south by Tanzania. It is the second most populous landlocked country after Ethiopia. The southern part of the country includes a substantial portion of Lake Victoria, shared with Kenya and Tanzania. Uganda has substantial natural resources, including fertile soils and regular rainfall (UNDP, 2007). Agriculture is the most important sector of the economy, employing over 66 percent of the work force (FAO, 2013).

Ugandan Agriculture is dependent on rain-fed crop and livestock farming (FAO, 2013). Livestock production is particularly important in the drier areas of the corridor that runs across the country from the northeast to the southwest and which is known as the cattle corridor (Lagu *et al*., 2006; UNDP, 2007).The livestock sector in Uganda is significant in importance to the agricultural sector and to the wider economy. It contributes 5 percent to the National GDP and 18 percent to agricultural GDP (Agriterra, 2012).

The dairy sector contributes about 50 percent of total output from the livestock sector, 20 percent of the food processing industry and 4.3 percent of the National GDP, and therefore acts as a source of food, income and employment (Ndambi *et al.*, 2006). Milk provides relatively quick returns for small-scale livestock keepers (Polak *et al.*, 2008) and is a balanced nutritious food, (a key element in household food security) (ILRI, 2003).The national cattle population has experienced steady growth with about 34 percent being dairy cattle. This has been attributed to the increasing demand by consumers and milk processing plants, better herd management, adoption of improved breeds and improved animal health and support services (UBOS, 2006). Dairy production is based on two contrasting systems; wetter parts of the country especially in western Uganda with commercial dairy farms and, drier Eastern and Northern parts where local Zebu cattle under traditional extensive management (Baltenweck *et al.*, 2007). Exotic breeds kept include the Jersey, Holstein, Friesian, Guernsey, Ayrshire and Brown Swiss (MAAIF, 2000).

Uganda's dairy farmers have worked to achieve self-sufficiency in the industry but have been hampered by a number of problems. Low producer prices for milk, high costs for animal medicines, and transportation problems were especially severe obstacles to dairy development. The World Food Program (WFP) undertook an effort to rehabilitate the dairy industry, and the United Nations Children's Fund (UNICEF) and other UN agencies also helped subsidize powdered milk imports, most of it from the United States and Denmark (Byrnes, 1992).

Kiruhura district lies in the South Western part of the country and is part of what is known as the Uganda cattle corridor, which stretches from north-east to south-west and occupies 40% of the country (Kyeyamwa, 2008). Livestock farming is a major part of the agricultural activities in the district, and livestock are mainly kept for dairy, as is the case for smallholder farmers. It is a major supplier of milk in the country with the highest number of farmers depending on dairying as their economic activity (Nkwasibwe, 2014; Wozemba and Nsanja, 2008). However, the farmers face a number of challenges to fully obtain profits from the milking activities. One of the major challenges faced is a low farm-gate price as compared to other sections of the country (Balikowa, 2011). Another one is lack of access to information about markets which may have a deficit of milk supply, and thus pay more, especially during the rainy season, when milk is in a surplus in the district and very low elsewhere. Farmers in Kiruhura District cited lack of access to market information as a major challenge they were facing (Ruhangawebare, 2010).

Information and Communication Technologies (ICTs), have become an important tool in promoting agricultural value chain efficiency. There has been a rapid expansion in the use of mobile technologies, in particular. The price of ICT services is falling and the technologies are becoming more affordable to many in developing countries. Applications can support farmers directly through SMS messages (World Bank, 2011b). ICT applications can improve linkages between procurers and smallholders in indirect ways as well

Availability of effective ICT, such as mobile telephony, at the hands of the farmers can be postulated as a key driver for improving farm productivity by diminishing information search cost and increasing efficiency (Ali and Frew, 2013).

In a study for the development of the pilot project iFARMS, which leverages mobile technologies to address the information and developmental needs of farmers in Western Uganda, it was found that rural farmers lack information about milk prices in urban markets (Okidi-lating, 2013). Additionally, the same study found that, due to high illiteracy levels and superstition, farm records were not being kept. The iFARMS software was subsequently designed to address both challenges.

There are a number of constraints to ICT use, and lack of confidence and lack of motivation are key factors in the adoption rate of ICT innovations (May *et al.*, 2007). Thus, the aim of this study is to gauge how far ICTs have gone along the dairy value chain in order to ease access to information, and increase the efficiency of the value chain.

In Kamuli district, Uganda, it was established that more than half of the farmers were using mobile phones to coordinate access to agricultural inputs, obtain market information, and to monitor agriculture emergency situations and financial transactions. Slightly less than half were consulting with experts via mobile phones. Members of farm groups were more likely to use mobile phones for agricultural-based purposes, especially consulting with experts. Women were less likely than men to access market information through the mobile phone. It further indicated that being part of a farm group and being male is associated with mobile phone use (Martin, 2010).

Kaplinsky and Morris (2002) define a value chain as the full range of activities which are required to bring a product or service from conception, through the different phases of production, transformation and delivery to final consumers, and eventual disposal after use. In this study, it is the full range of activities required to bring dairy products from conception, to the consumers, to disposal. The actors in the dairy value chain are: Dairy farmers (formal and informal), Transporters (Vehicles and Bicycles), Bulk Collectors, Milk Processors, Milk retailers, and Dairy Cooperative and farmer groups.

In summary, ICT use is very important in increasing productivity and profitability of agriculture value chains (of which dairy value chains are a part). However, up to date data on the ICT sector is very limited in the developing world (ITU, 2014). Thus, this study

seeks to assess extent of ICT use in the dairy value chain in order to provide much needed data and paint a clear and concise picture of the information society in the study area.

1.2 Statement of the Problem

According to an ITU report on Measuring the Information Society, data on the information society in developing countries is limited, nonexistent or not up to date (ITU, 2013). This is evidenced in Uganda by the limited number of published studies involving the various ICTs and Agriculture, and the proposed research on the impact of ICT on costs of milk and vanilla operations (Hale wood and Surya, 2012). The Dairy Value chain analyses done by East African Dairy Development Program (2008), Mwebaze and Kjaer (2013), Balikowa (2011), Wozemba and Nsanja (2008) contain no mention of the use of ICT within the dairy value chain. This illustrates the lack of data on ICT and the dairy value chain in Uganda. The study aims to contribute to the growing body of knowledge of the Information Society in Uganda, particularly with respect to the dairy value chain.

The Government of Uganda formulated the National IT Policy in 2011 to harness the Information Technology subsector to contribute to national development (NITA, 2015). Rural Communications Development Fund (RCDF) had, among it's specific objectives, "Increase coverage and broaden basic ICT services Specific objective" and "Development of local and relevant content" (Uganda Communications Commission, 2009). However, as the report notes, it still needs to "partner with other programs that aim to accelerate poverty reduction in rural areas, particularly in situations where ICT has potential to play a strong catalytic role, such as education, health, agriculture." (Uganda Communications Commission, 2009).This statement reflects the reality on the ground; the lack of empirical data on ICT use in agriculture based enterprise (Mutonyi and Norton, 2007). The study therefore aims to increase the amount of information available on the use of ICT in agribusiness in Uganda in general, and Kiruhura District in particular.

Thus, despite all the advantages offered by ICTs in improving livelihoods of rural populations, especially as regards agricultural productivity and market linkages, there is no substantial body of data of agriculture-related ICT use in Uganda as a whole, and Western Uganda in particular. There is also lack of empirical data regarding ICT adoption in the

dairy sector. This leads to knowledge gaps by policy and decision makers as they do not know the true and empirical extent and effect of ICT use on the livelihoods of the rural populace and thus cannot effectively direct policy and initiatives to help in this regard. This lack of data, specifically, the ICT use by dairy value chain actors in Western Uganda, is addressed by this study, and stimulate further initiatives and academic discussion in this regard.

1.3 Scope and Limitation of the Study

The study was carried out to assess the use of ICT along the dairy value chain in Kiruhura district, Uganda. It investigated the use of ICT for information gathering, and dissemination by the actors along the dairy value chain.

ICT being a broad term, the study focused on the most popular ICTs in use today; Mobile phone, television, radio, and internet. Furthermore, in mobile, the study established whether SMS, voice calls or mobile internet were being used.

1.4 Significance of the Study

Statistics on access to, and use of, information and communication technologies (ICTs), are critical to formulating policies and strategies concerning ICT-enabled growth, for social inclusion and cohesion, and for monitoring and evaluating the impact of ICTs on economic and social developments. However, internationally comparable information society statistics are very limited, in particular in the developing world.

In Uganda, it was noted that there is lack of information regarding inputs, financing, and markets. There is also limited information by the authorities on farmer groups (Wozemba and Nsanja, 2010). This study therefore found out how the knowledge intensive dairy sector actors are bridging the information gaps, and the effectiveness of such innovations.

Furthermore, evaluations are usually carried out on projects that are carried out by formal organizations, such as NGOs and Government ministries. This study carried out an evaluation within an informal organization. The information obtained therein will serve as

an aid to formal organizations as regards the current market structure, and appropriate measures that can be taken to strengthen the various levels of the value chain.

According to Shadrach and Summers (2002) at the national and international level, there is a need for demonstrating the usefulness of these technologies so that policy-makers can frame policies that encourage utilization of ICTs in developmental efforts. This should result in improved connectivity, reduced costs and in increased access to ICTs by all sections of the population (UCC, 2009). NGOs, medium and small-scale enterprises (MSMEs) and IT organizations are very keen to assess the acceptance level of ICTs among the users so that they can develop a better understanding of the business dimensions of these technologies (UCC, 2009).

Designers of information systems need to have a thorough understanding of user behavior to ensure that the technologies and information systems are appropriate to the context in which they are to be used (Shadrach and Summers, 2002).

Therefore, this study will contribute to the existing body of knowledge about ICT prevalence in the dairy value chain and has painted a clearer picture of ICT use in the study area in order to provide decision makers at all levels (in the private sector and government) with the relevant information required to create initiatives that will boost the information flow along the dairy value chain.

1.5 Objectives of the study

The general objective of the study is to assess the extent of ICT use along the dairy value chain in Western Uganda

Specific Objectives

1. To determine which ICTs are used by the various actors in the dairy value chain.
2. To determine the challenges facing the adoption of ICTs in the dairy value chain
3. To determine the extent of use of the identified ICTs in various sections of the Dairy Value Chain in Western Uganda.

1.6 Organisation of the thesis

This thesis consists of five chapters. Chapter one deals with the background, problem statement, objectives and significance of the study. Chapter two reviews literatures related to the main research topic. In chapter 3, Research Methodology and Study area are presented. Chapter 4 has the results of the study along with discussions interpreting the results. Chapter 5 summarizes and concludes the thesis and forwards recommendations along with suggestions for further study in the thematic area.

2. LITERATURE REVIEW

2.1 ICT in Dairy Production

ICTs can play a vital role in poverty alleviation by empowering the rural poor to access markets, health care and other services provided by the government. The role of ICT in dairy production is continually increasing in importance. ICTs, gives the rural people greater access to needed information and gives governments of developing countries tools for cheaply and quickly assessing the situation on the ground (Siraj, n.d.). Practitioners in Information and Communication Technology (ICT) for development have repeatedly relied on evaluations of past or present initiatives to advise and facilitate the design and implementation of other development initiatives. However, current quests for measures that demonstrate the developmental contribution of ICT call for new approaches to ICT4D evaluation (Kivunike *et al*., 2013). Taking this into context, this section will look into the benefits of ICTs, the reasons for evaluation of ICTs, the value chain approach, the information flows in the value chain, one of the models for adoption of technology, and finally presents the conceptual framework of this study.

2.2 Evaluation of ICT

Information and communication technologies (ICTs) comprise a complex and heterogeneous set of goods, applications and services used to produce, distribute, process and transform information. They include the outputs of industries as diverse as telecommunications, television and radio broadcasting, computer hardware and software, computer services and electronic media (e.g., the Internet, electronic mail, electronic commerce and computer games.)(Marcelle, 2000)

Practitioners of ICT for development rely on evaluations of past or present initiatives to advise and facilitate the design and implementation of development initiatives (Heeks and Molla, 2009). Richard Heeks then proceeds to provide a framework for evaluation of ICT for development projects. However, the approach carries out an assessment of ICT within the confines of a formal organization or project, and does not address informal, loosely coupled enterprises. Shadrach and Summers (2002) detailed the reasons for carrying out

ICT evaluations at the national, managerial and user level (Shadrach and Summers, 2002). As evaluation is important, it is important to know the advantages ICT provides so that current performance can be measured against them (Heeks and Molla, 2009).

According to Michal Levi numerous operational effects of ICT capabilities can be found in the literature (Levi *et al*., 2012). In order to create a comprehensive and yet a clear and effective framework, they were categorized as follows:

2.2.1 Operational Benefits of Using ICT

Reduce production cost and improve efficiency

ICTs, in the form of traceability systems, increase production efficiency by reducing paperwork and enhancing the ability to quickly generate reports and identify problems. These systems can also reduce costs by improving inventory control, thereby reducing waste (Rodrigues and Rodríguez, 2013)

Reduce supply chain cost and improve efficiency

ICTs are also being used in distribution and supply chain management and traceability to increase efficiency and predictability and to reduce spoilage (including recording movements along the value chain, responding to quality standard requirements, and helping large buyers track, manage, pay, and reward small producers) (Asenso-okyere and Mekonnen, 2012).Through supply chain management practices dairy cooperatives can minimize their system wide costs and also provide maximum value to their customers (Kumar, 2014)

Reduce coordination costs

By lowering the costs of communications, ICTs improve the monitoring and coordination capabilities of organizations. Moreover, they will be most susceptible to network effects: the value of the technology will be increasing in the number of other users (Forman and Goldfarb, 2006)

Improve customer service

The Directorate of Agricultural information of Punjab provides a public free toll help line. Customer information is stored in a Customer Database, and helps the agency to provide better tailored services to the customers (Siraj, n.d.). A study on manufacturing companies in southwestern Nigeria ranked improved customer service as a perceived benefit of ICT utilization with a score of 3.70 on a scale of 1-4 (Adebambo and Toyin, 2011).

2.2.2 Strategic Effects of Using ICTs

Each of the operational effects stated above may lead to strategic effects, which were also categorized thus:

Productivity

In a study of the role of mobile phones in improving communication and information delivery for agricultural development conducted in South Western Uganda, it was found that there was a peak usage of phones during planting and harvesting seasons. Majority of the farmers used the phone to call stockiest, technocrats and traders due to the fact that crop husbandry is one of most important livelihood activities in the study area (Masuki *et al*.,2010). As most of the agricultural production system in this region is rain fed, use of mobile in weather updates would boost agricultural productivity as farmers will be aware and plan when to plant their crop.

Profit margin

In Senegal, a project was implemented by an organization called Manobi, which independently collected prices and uploaded them to its central database using mobile phones that dial in to the server via WAP (wireless application protocol). Farmers in the field were able to check prices before they set off and find out the best offer of their produce. It was found that the farmers have secured, on average, about 15% higher profits

for their farms after having paid net costs, including the price of Manobi's service (Rashid and Elder, 2009).

Quality of product and service

E-sagu is a tele Agriculture project started in 2004 by the International Institute of Information Technology IIT, Hyderabad, and Media Lab Asia. E-sagu delivers farm-specific, query-less advice, typically once a week from sowing to harvesting. This service reduces the cost of cultivation and increases farm productivity as well as the quality of agri-commodities (Brugger, 2011).

Customer loyalty and satisfaction

In East Africa more broadly, mobile phones are used for money transfers, market information sharing, agronomic advice, plant disease identification, and agro dealer customer loyalty programs (Lama *et al*., 2014).

Differentiation

Traceability systems are also being used for a variety of other purposes related to value-added marketing, like geographic origin and organic products. In this regard, traceability systems facilitate access to markets and provide new opportunities for product differentiation. Traceability systems are information intensive; hence, ICTs play a key role (Rodrigues and Rodríguez, 2013).

Social responsibility and sustainability

The GSMA, the body that represents the interests of mobile operators world-wide, recently announced the launch of the mFarmer Initiative Fund, supported by a grant from the Bill and Melinda Gates Foundation. It is an innovative idea strongly based on win-win aspects of any collaborative venture. Not only does the GSM association gain through it by increasing penetration, thereby increasing revenues to its operators, but it also helps its corporate social responsibility (Deloitte, 2012),

Agility.

In Tanzania, milk processors experimented with organizing transport from collection centers to the plants. One firm contracted with a private trucking company to do the collection. Through the spread of information and communication technologies (ICTs), especially cell phones, transporters have become more responsive and flexible to producers and input suppliers (Larsen *et al.*, 2009).

ICTs are also being used to strengthen the capacity of extension officers and NGO field staff to reach farmers with timely and accurate information and, at the same time, help capture data from the field (Sen and Choudhary, 2009). An example is the Grameen Community Knowledge Worker initiative in Uganda (World Bank, 2011). ICT also helps in traceability of the agricultural products, and thus transporters, bulk cooling and collection centers and processors can link up to ensure efficiency and predictability of milk production. In Tanzania, it was found that through the spread of ICTs, especially mobile phones, agribusiness transporters were able to be more responsive and flexible to input and produce suppliers (Larsen *et al.*, 2009).

In agriculture, mobile phones can play many important roles towards improving the overall efficiency of the value chain. One of the key impediments, inherent to the conventional agriculture value chain is asymmetry of information among the various actors. This result in wastage and quality degradation, which in turn result in economic losses, especially for the smallholders, who typically stay at the far end of the value chain and are deprived of resources to integrate their operation both in forwardly and backwardly (Sylvester, 2013).

ICT has been shown to ease the cost of communication, and also join farmers to external markets. Integration of ICT solutions in the monitoring and evaluation processes increases impact and efficiency of agriculture value chain interventions, allows the systematic changes to sustain themselves, and ensures regular incorporation of farmers' feedback into project design and implementation. It allows for reducing costs and time, improving data validity, and building ownership and participation (IICD, 2014). Farmers are also able to make better decisions based on current market price information.

2.3 Value Chains in Agriculture

The value chain describes the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use (Kaplinsky and Morris, 2000). By extension, the dairy value chain is the full range of activities which are required to bring dairy products from conception, through different phases of production, delivery to consumers, and final disposal after use.

A major subset of value chain development work is concerned with ways of linking producers to companies, and hence into the value chains (Shepherd, 2007). Work to promote market linkages in developing countries is often based on the concept of "inclusive value chains", which usually places emphasis on identifying possible ways in which small-scale farmers can be incorporated into existing or new value chains or can extract greater value from the chain, either by increasing efficiency or by also carrying out activities further along the chain (Haggblade and Theriault, 2012).

Agricultural value chain finance is concerned with the flows of funds to and within a value chain to meet the needs of chain actors for finance, to secure sales, to buy inputs or produce, or to improve efficiency. Examining the potential for value chain finance involves a holistic approach to analyze the chain, those working in it, and their inter-linkages.

Governance is a dynamic feature of value chains that characterizes the relationships or linkages among stakeholders in the chain. Governance is important as it relates to the ability of a stakeholder to determine, control and/or coordinate the activities of other actors in the value added chain. The stakeholders who establish parameters can be one or more firms in the chain, actors in the larger enabling environment, or a combination of the two. By setting the parameters for governance, powerful actors influence who acquires production capabilities and market access and how gains are distributed throughout the chain (Frederick and Gereffi, 2004).

2.4 Dairy Value Chain in Uganda

The milk supply chain in Uganda entails the flow of milk from the farm level, through the trader/agents/transporters, milk collection centers and processor and finally the consumer. This process takes two forms; the formal supply chain for processed milk and the informal chain for unprocessed milk, which appears to be more problematic due to the continuous entry and exit of different agents from time to time, particularly in this era of liberalization. More than 90% of milk produced is consumed without being processed which means that supply chain for unprocessed milk is more voluminous and gives vendors and licensed milk traders a lion's share of the milk trade in the country (Wozemba and Nsanja, 2008).

The value chain of both the formal and informal market is fragmented with a large number of players at each step, and a low level of vertical integration, with some rare exceptions (small processors such as Jesa, White Nile). In the formal value chain, the milk is first transported to primary collection centers and to chilling and bulking centers before being delivered to a processing facility. Once milk is processed, agents or distributors deliver it to a point of sale.

The informal market connects producers to consumers normally via a number of hawkers/brokers.

The main characteristics of the dairy value chain in Uganda are as follows: (i) prevalence of the informal sector, (ii) lack of critical mass and (iii) high variability of milk price at the farm gate.

(i) Even though the formal sector offers higher accountability and certainty of daily revenues, most milk is still sold in the informal. The preference for selling into the informal market is driven by higher prices, cash payments and lack of a required minimum scale. The informal sector (i.e. brokers) pays in cash on the spot, while processors usually pay after two weeks. Considering that milk is often the only recurrent revenue for farmers, the need for cash to cover daily expenses creates a strong preference for producers to sell to informal traders/hawkers. In addition, there

is no quality control in the informal market allowing producers to sell poor quality milk that would be rejected by processors.

(ii) Milk can sit in primary collection centers for days before being transported to the bulking and chilling center because transporters need a minimum quantity of milk in order to make profit out of a trip. Such a problem, while still manageable in the wet season (up to two days), dramatically worsens in the dry season, during which milk can sit for up to four days in a primary collection center. Lack of critical mass also affects processors. Most processors invested in processing capacities designed for wet season milk supplies. In the dry season, though, most of them face utilization ratios as low as 30% (Wozemba and Rashid, 2008).

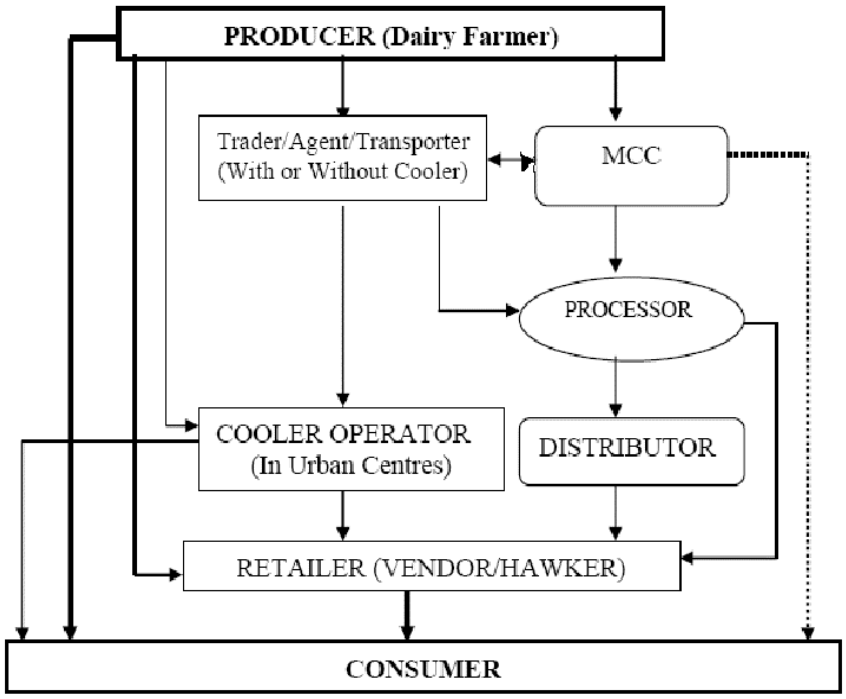

Figure 1: Milk Markets and Marketing Channels. Source: Odele (2006)

Figure 2 highlights the different channels that are contained in the Uganda dairy value chain. The Formal market channel is where milk is sold to companies who process it and later sell milk products to consumers. The Informal market channel is whereby dairy farmers are directly connected to the consumers and sell to them milk and milk products. The formal milk channel is characterized by longer distances, better transportation means and use of milk processing technology. The informal channel is characterized by shorter

distances and less technology (Choudhry *et al.*, 2011). However, in both channels ICT is used along the value chain by different actors for different functions as discussed above. Figure 3 shows the actors in the Uganda Dairy Value Chain and paints a clearer picture of the sector.

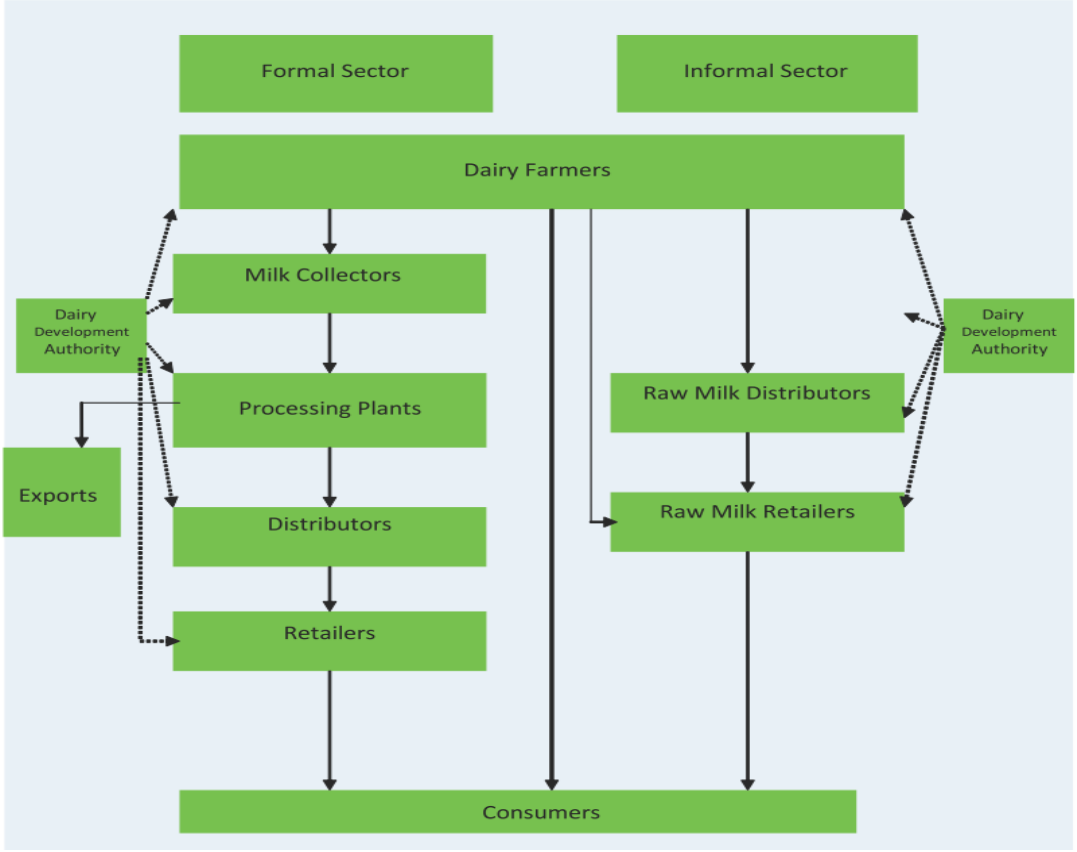

Figure 2: The Uganda dairy value chain, showing both Formal and Informal market channels. Source: Technoserve (2008)

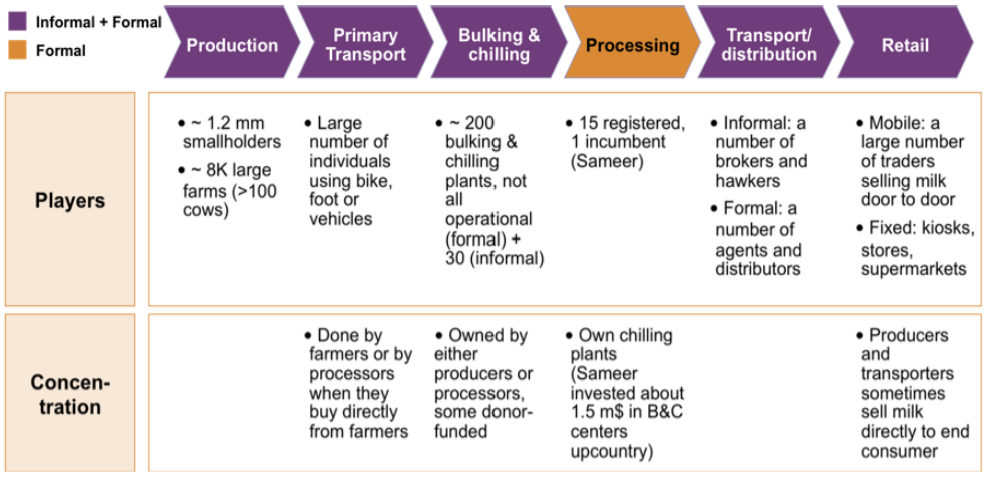

Figure 3. Players in the Ugandan dairy value chain. Source: TechnoServe (2008).

2.4.1. Dairy Value Chain actors and ICT

These are the participants in the dairy value chain and are composed of Dairy farmers, Transporters, Bulking and Chilling Centers, Milk Processors, Farmer Groups or Cooperatives and Inputs suppliers (Odele, 2006).

Dairy Farmers in the southwestern milk shed of Uganda on average have the largest farms, with an average farm size of 19 acres. The milk shed is generally inhabited by traditional cattle-keeping tribes and also has the largest settlements of pastoral communities whose main source of livelihood is cattle rearing. As a result of the increased demand for milk, the producers see dairy as a commercial activity and are intensifying production to increase output (Choudhry *et al.*, 2011). Farmers mainly use the mobile phone to gather information and coordinate transport of milk to the collection centers. They also use radios, in tandem with mobile phones to get dairy industry related information.

Transporters include truck transporters, who can be independent, or employees of milk processing companies, bicycle and motorcycle transporters, and drivers of pickups. They are mainly employees of the farms, but there are some who aggregate milk from various farms to transport to the chilling center (Choudhry *et al.*, 2011). Transporters rely heavily on the mobile phone in order to ensure that the flow of products is smooth. The managers

of the processing companies and the bulking centers also monitor the movement of milk products using mobile phones.

Bulking and chilling centers are the collection centers where farmers bring their milk in order to be transported to the bigger milk processors. They have computerized milk coolers and have a payment arrangement with the farmers, mostly using payment delivery books. They are owned by the milk processors and also by farmer cooperative groups (Sikawa and Mugisha, 2011). Bulking centers use computerized coolers. Center managers use mobile phones to communicate with farmers, transporters and also further along the chain, to the milk processing company.

Milk processors include Amos dairies and Peal dairies, which are both near the Kiruhura town council. Amos dairies is at the periphery of Kiruhura District and Pearl dairies is in Mbarara district. There are also many small scale milk processors in the district. Processors use computerized milk processing machines. They use computers for stock management, payments to farmers, payroll and many business processes. Mobile phones are used mainly to communicate with truck drivers and bulking centre managers. Radio and television are basically avenues for advertisement.

Farmer groups or cooperatives. These are organizations that bring farmers together with the interest of strength in numbers for bargaining purposes. They also purchase and maintain milk coolers at bulking and collection centers. The main ICTs in use are the mobile phone and computer, for communicating among farmers and keeping records.

Input suppliers include concentrate feed producers and retailers, industries selling by-products as dairy feeds, breeding and animal health service providers (owners of veterinary clinic, veterinary pharmacy, paravets, community animal health workers), improved forage and pasture seeds, credit services, and value addition technologies. (Kuma, 2012; Lemma *et al.*, 2010).

2.5 Information Flows along the Agriculture Value Chain

Some surveys have clustered mobile applications around the categorization of information flows in agricultural value chains according to the inter-stakeholder communication needs that are satisfied. Parikh *et al*., 2008 distinguish three categories: a) link-to-link (L2L): those information flows required to coordinate the distribution of produce along the value chain, b) peer-to-peer (P2P): communications required to share knowledge and experiences between members of the same stakeholder group, and with the expert community serving that group and c) end-to-end (E2E): communications between producers and consumers, to facilitate exchange of non- economic values as external inputs to market pricing (e.g. certification) (Brugger, 2011).

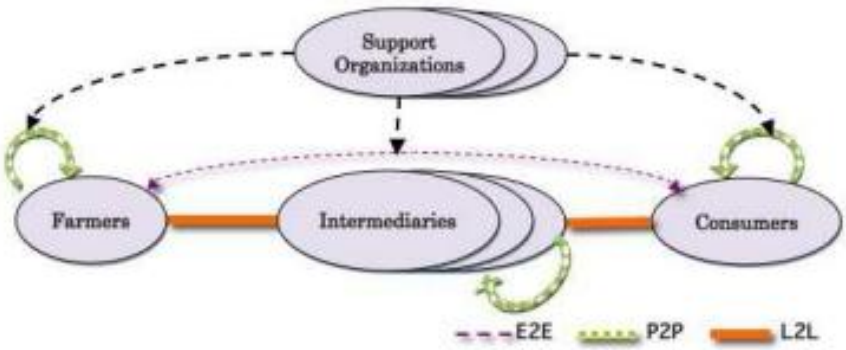

Figure 4. Categories of information flows in agricultural value chains. Note:-Black dotted lines represent supporting activities. Source: Parikh *et al*., (2007)

Additionally the flows can be clustered according to the function of information in the farming process (Brugger, 2011).

A) Extension services: Applications discussed under this category cover communications required to transfer and exchange knowledge and experiences to and among farmers, to facilitate the dissemination of information from research and extension agencies to farmers. This information flow addresses the significant skills deficit among small producers, and offers the potential to reach many more farmers than relying on traditional extension channels only.

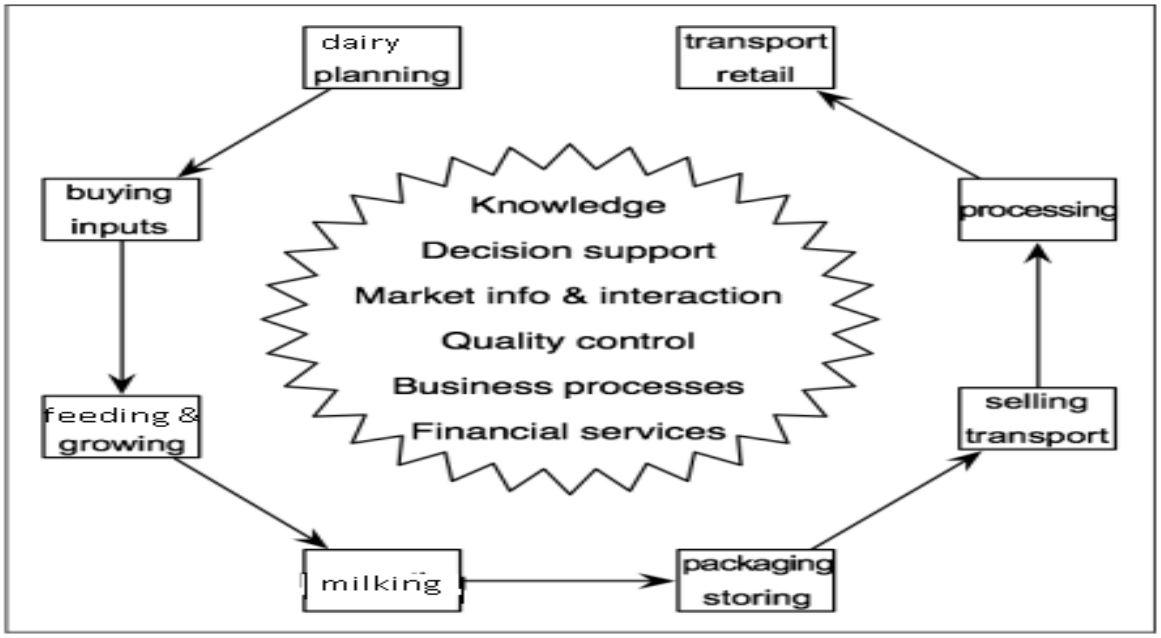

Figure 5. Information requirements and business processes offering opportunities for mobile applications along the value chain.

Mobile projects in agriculture extension can be clustered in two broad categories. The first category is m-Learning**.** This is the transfer of general know-how on farming techniques and trends, information on plants and varieties and how to grow them. This mainly takes the form of one-way push communication to subscribers to a service (e.g. general information related to particular crops, weather forecast) or enables users to send queries to a database. More interactive forms also offer possibilities for exchanging experiences among farmers.

The second category is mFarming. Individual decision-support systems and services based on localized contextual information, i.e. delivering location-specific (spatial) information based on microclimatic patterns, soil and water conditions throughout the cropping season, in order to inform decisions on agricultural measures to optimize plant growth. In essence, this is about making some key elements of "precision farming "available to small producers. MFarming requires remote sensing instruments and GIS. It can also involve advice systems such as remote diagnosis of diseases by experts.

B) Quality control: communications between sellers and buyers, producers and consumers, to facilitate exchange of quality of product (e.g. grading) and non- economic

values as external inputs to market pricing (e.g. certification of fair trade products, adherence to quality standards, ecological footprint, verification of origin of product).

C) Logistics and business process management: Applications that facilitate sound business processes in rural areas (e.g. transporting agricultural commodities, tracking goods, organizing seller/buyer accounts).

D) Financial services: Communications and processes to provide financial services such as payment or insurance to rural farmers and agents involved in the agriculture value chain. Applications in this area particularly address the issues of distribution, outreach and business processes that enable dealings with clients in rural areas.

E) Data collection: The last category is not unique to agriculture, but does support agricultural development. Data collection is often used to inform extension services, research, policy-making and market intelligence. It includes surveys on farming practices and general collection of data related to the agriculture value chain.

2.6 Communication Needs of Actors in the Agriculture Value Chain.

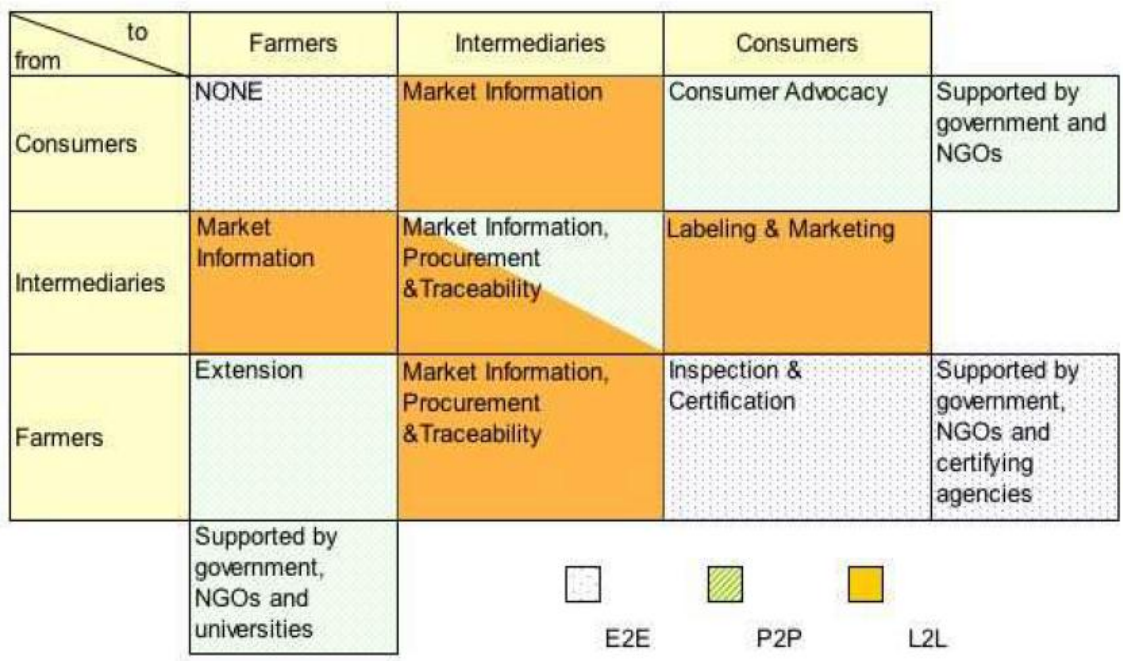

Figure 6: The communication needs satisfied by the various categories of agricultural information systems. Note: The matrix cells represent specific pairwise communication links. L2L links are indicated in orange, P2P in green and E2E in white. Source: Parikh *et al*. (2007).

2.7 The Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Viswanath Venkatesh, aims to explain user's intentions to use ICT and subsequent usage behavior. From the model, four key constructs are theorized to influence usage intention and behavior. The theory was developed through a review and consolidation of the constructs of eight models that earlier research had employed to explain information systems usage behavior (theory of reasoned action, technology acceptance model, motivational model, theory of planned behavior, a combined theory of planned behavior/technology acceptance model, model of personal computer use, diffusion of innovations theory, and social cognitive theory) (Venkatesh, 2012). The combinations of the constructs and moderating factors increased the predictive efficiency to 70%, a major

improvement over previous TAM model rates. A study by Kahenya *et al*., (2014) sought to test the strength of the hypothesized relationships mentioned in the theoretical model and the appropriateness of the model in predicting users' use of ICT in Agricultural Extension knowledge management. Four constructs are theorized by the UTAUT model as predicting Information Systems usage behavior; Performance expectancy, Social Influence, Facilitating conditions and Effort Expectancy (Kahenya *et al*., 2014; Venkatesh, 2012).

On the left side of Figure 7, we have the four main constructs of Performance expectancy, Effort expectancy, Social influence and Facilitating conditions. These interact with the user characteristics of Gender, Age, Experience and Voluntariness of use to produce Behavioral intention of using an ICT. Behavioral intention and Facilitating conditions produce use behavior. Facilitating conditions are affected by Age and experience in determining whether a particular technology will be used.

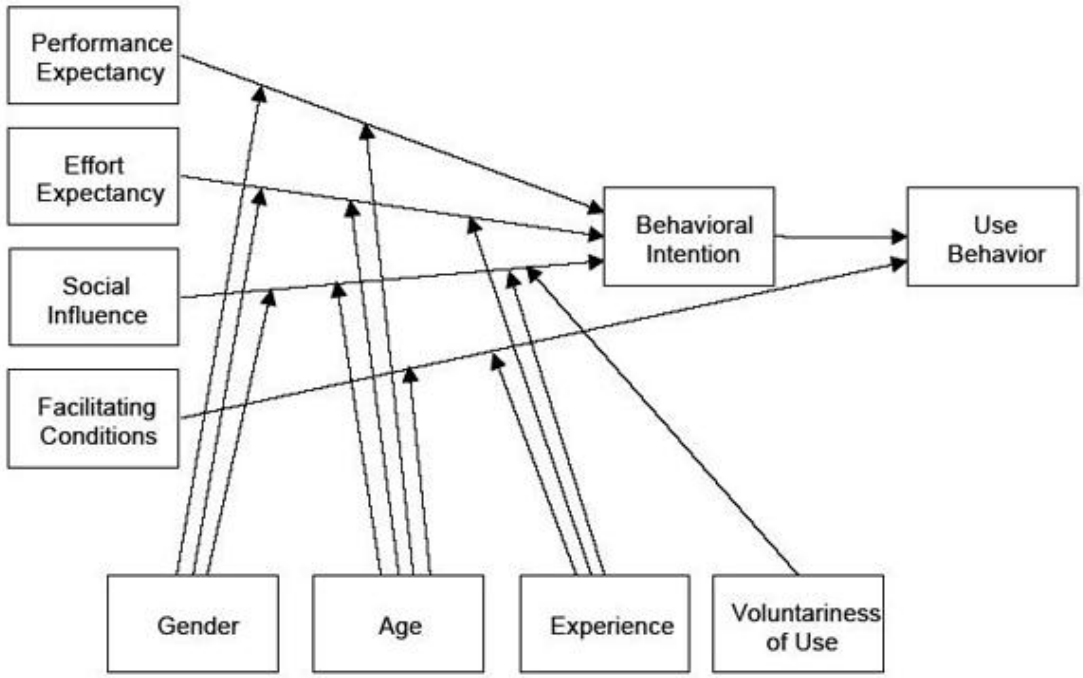

Figure 7. UTAUT model diagram, and attending factors. Source http://www.vvenkatesh.com

Figure 7 formed the major basis for assessing the use of ICT along the dairy value chain in the area of study. The variables are explained in the methodology section.

2.8 Conceptual Framework of the Study

The Literature review has established that ICT use in agriculture has a number of advantages for agricultural enterprise. It has also shown that the information flows in the agriculture value chain can be classified in 2 ways; among actors, and by the use of the information. It has shown a model of adoption of technology that is commonly used to assess use behavior of technology. This leads to the conceptual model shown in the figure below.

The conceptual framework shows that the study examined the relationship between value chain actor characteristics, demographics, perceptions and attitudes, ICT related variables and the Extent of Use of ICT in the dairy value chain.

The dairy value chain actor characteristics are the main traits of the dairy value chain actors from which we can gain general information. The Demographics of the dairy value chain actors collect demographic information from each value chain actor. ICT related variables talk about the ICT capabilities of the dairy value chain actors with respect to each of the four ICTs under investigation. Perceptions and attitude are the views held by the user on aspects of use of each of the ICTs. This will in turn affect use behavior of the ICTs. Use behavior is what will affect the extent of use of ICT along the dairy value chain. The extent of use is an index that aggregates perceptions and attitude of users. It is affected by the use behavior of the users, who are the dairy value chain actors in this case.

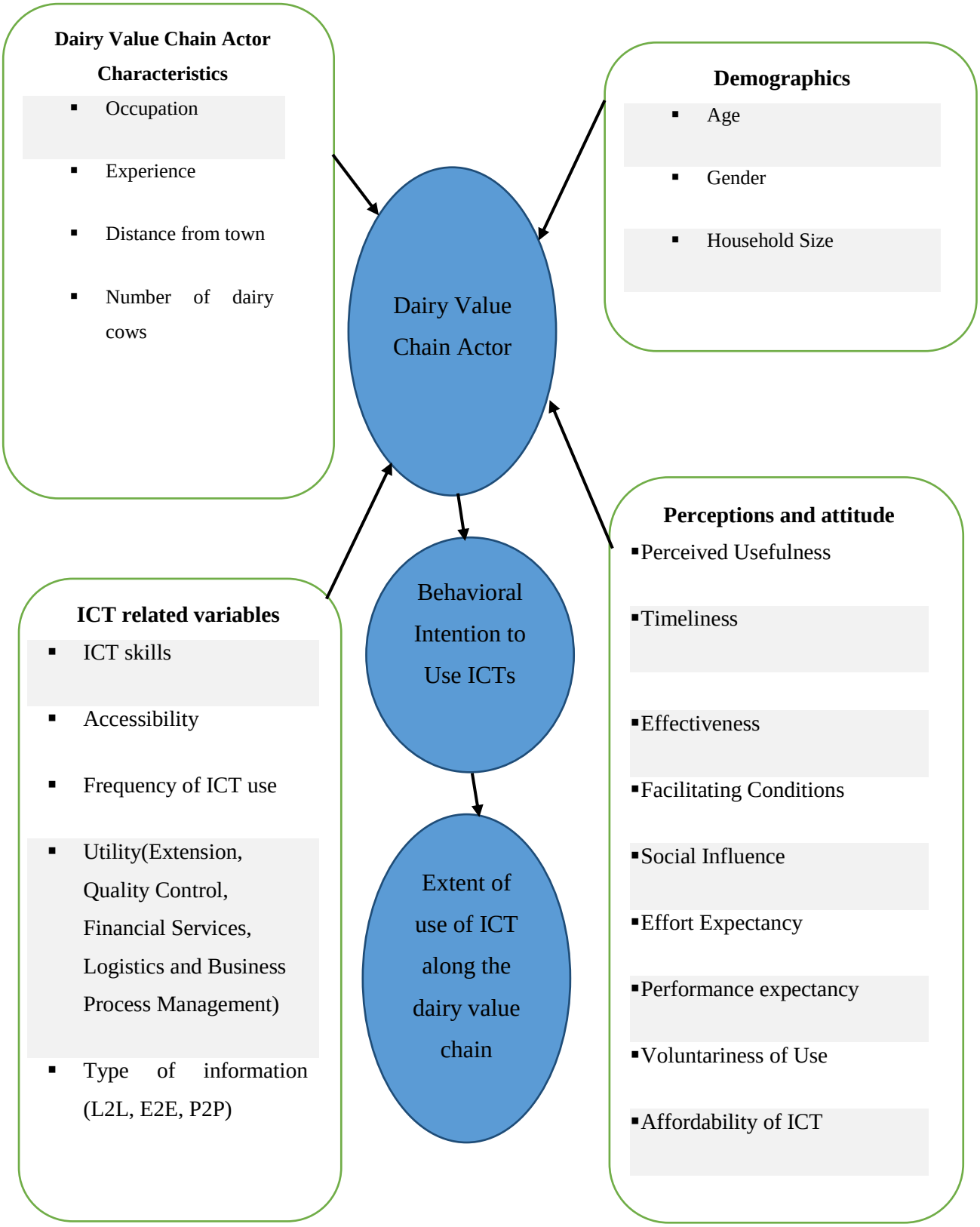

Figure 8: Conceptual Framework of the Study

3. METHODOLOGY

3.1 Description of the Study Area

The study was carried out in Kiruhura district, south western Uganda. The district is located in the cattle corridor of Uganda and experiences two different seasons every year: wet and dry season. Kiruhura is bordered by Rakai district in East, Sembabule district in northeast, Kyenjojo in North, Mbarara district in west and Isingiro district in East. Its population is estimated at 322,200 people (Uganda Bureau of Statistics, 2014). The vegetation cover is savannah grassland with shrubs. The economic activity in the district is cattle rearing with mainly Ankole cattle, Hybrid (mixture of exotic and Ankole) and Boer goats. The district produces approximately 100,000 liters of milk per day. The reason for the selection of Kiruhura district is because of being a major supplier of milk in Uganda with the highest number of farmers depending on dairying as their economic activity (Sikawa and Mugisha, 2011).

The farming system in Kiruhura district is mainly a livestock production system, practising communal and paddocking grazing systems of indigenous and improved dairy cattle. A 2008 national livestock census put the number of cattle in Kiruhura district at 342,315 (Uganda Bureau of Statistics, 2014). Only 2 percent of roads are tarmacked (Kamugungunu, 2012), leading to transportation problems especially in the rainy season. It is a part of the Southwestern milk shed which has historically been a major milk producer, with the highest concentration of milk-collecting and milk processing infrastructure in the country. In the southwestern milk shed, the common grazing systems include free-range grazing (cows graze all over the farm freely) and fenced grazing (cows graze around paddocks), although the famers are quickly adopting the zero grazing system, particularly in areas where grazing land has become scarce. Milking is done twice a day, in the morning and evening. The predominant cattle breeds include the local Ankole Longhorn, crossbreeds, particularly between the locals and Friesians or Jerseys, and exotic breeds, mostly Friesians and Jerseys (The World Bank, 2011).

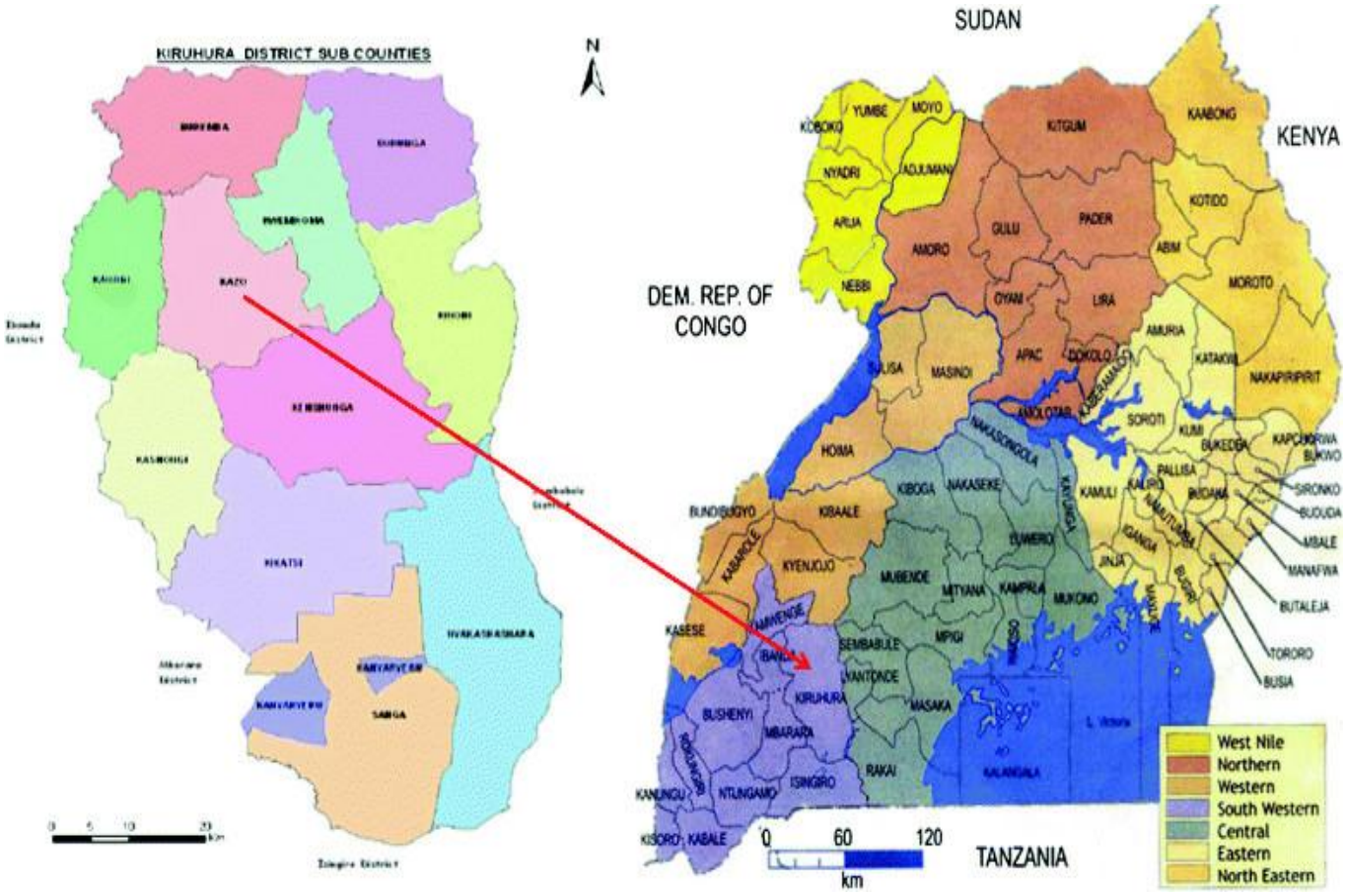

Figure 9: A map of Uganda showing Kiruhura District. Source: Uganda Bureau of Statistics (2014)

From the district, four sub counties were chosen. The first sub county, Kashongi was chosen at random, then three of the surrounding sub counties were chosen due to convenience. The chosen sub counties were Kashongi, Kikatsi, Kenshunga and Kazo.

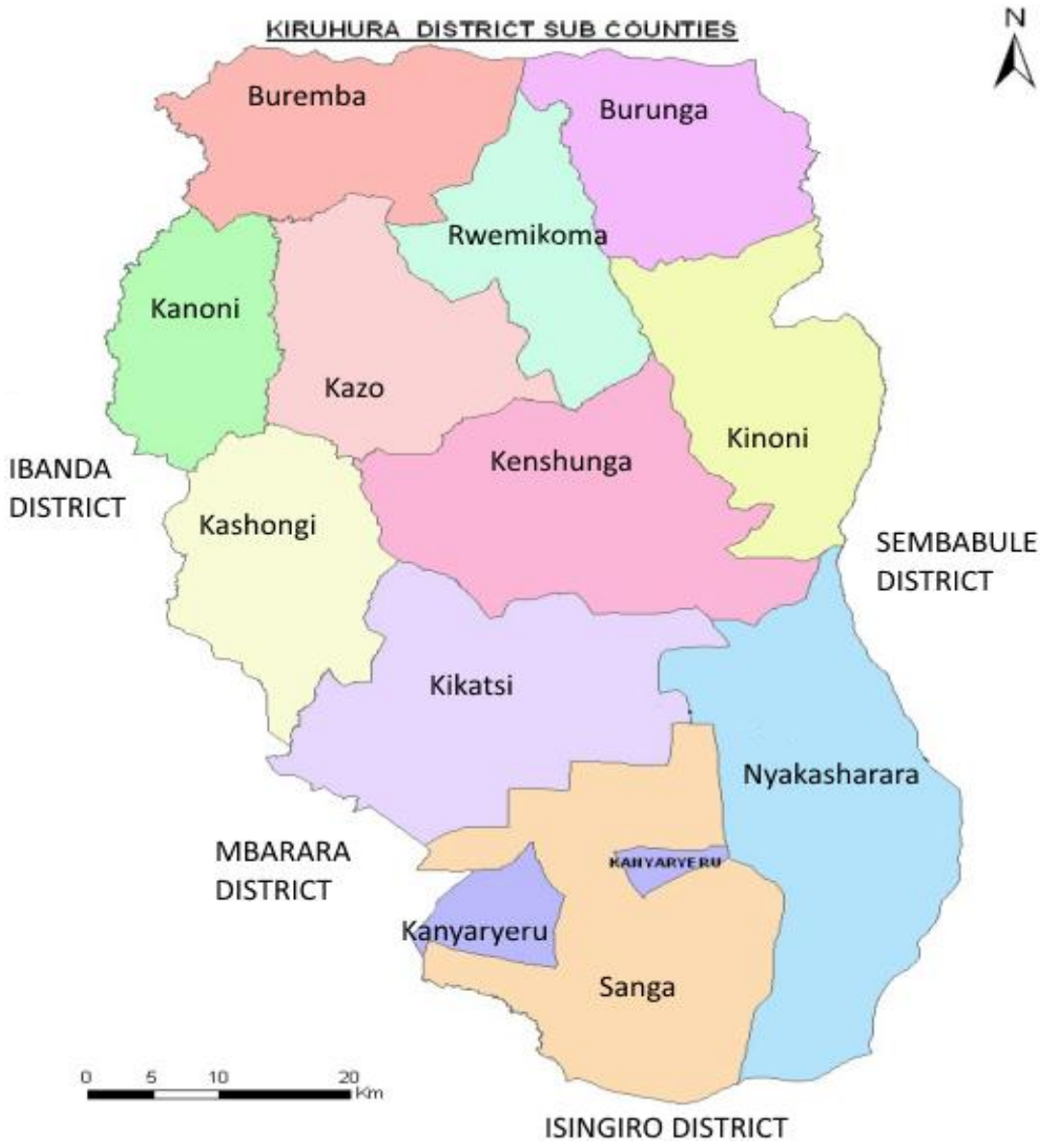

Figure 10: Kiruhura District showing sub counties Source: Uganda Bureau of Statistics (2014)

3.2 Population and Sampling Methods

Kiruhura district was selected because it is one of the major milk producing districts of Uganda with the region producing 36% of the national milk production, and having 80% of operational milk coolers in the country (Choudhry *et al.*, 2011). Four out of 11 sub-counties were randomly chosen for the study.

The dairy value chain in Kiruhura District, for purposes of this study is composed of Dairy farmers, Transporters, Bulking and Chilling Centers, Milk Processors, Farmer Groups or Cooperatives and Inputs suppliers (Odele, 2006). Thus, my target population is dairy value chain actors in Kiruhura District.

A three stage sampling procedure was followed. First, Kiruhura district was purposively chosen because of the high concentration of dairy farmers in the district (Sikawa and Mugisha, 2011) Then, Kashongi sub county was randomly selected as a starting point . From here, three surrounding counties were chosen, namely Kikatsi, Kenshunga and Kazo, due to the convenience of proximity to Kashongi. This was done in order to facilitate the free movement of data collectors within the selected area, in order to maximize available resources. Using the unit of analysis as a dairy value chain actor, survey respondents were randomly chosen, and the various occupations are represented in Table 1. The sample size is 162 and the unit of analysis is the dairy value chain actor.

Table 1 Proportion of Dairy Value chain actors in the sample

Occupation				
	Frequency	Percent	Valid Percent	Cumulative Percent
Farmer	73	45.1	45.1	45.1
Truck transporters	8	4.9	4.9	50.0
Other transporter	34	21.0	21.0	71.0
Bulk collection centre personnel	10	6.2	6.2	77.2
Processing plant personnel	6	3.7	3.7	80.9
Informal retailer	16	9.9	9.9	90.7
Formal retailer (shops)	5	3.1	3.1	93.8
Dairy Cooperative Personnel	7	4.3	4.3	98.1
Inputs supplier	3	1.9	1.9	100.0
Total	162	100.0	100.0	

Source: Own Survey Data, 2016.

The study used both primary and secondary data. Where the population member is an organization, the interview schedule was administered to the person in charge of the organization, or to a delegated respondent from within the organization. This ensures the homogeneity of the population as dairy value chain actors in Western Uganda. A similar approach was done by Mbiha (2008), who used Hotel and Bar owners as part of her sample.

3.3.1 Primary Data

A cross-sectional survey was done to collect primary data using a structured interview schedule. A cross-sectional survey takes a snapshot of the scenario at a point in time. The interview schedule consisted of open ended questions, closed questions and. Focus group discussions were conducted with groups of value chain actors, mainly dairy farmers and transporters. Individual interviews with some key informants were also used to collect data and reinforce findings from the field. The interviews were conducted using a checklist as shown in Appendix 5. Qualitative and quantitative data were collected for this study. Qualitative data was collected on perceptions towards ICTs and ICT use, these included; perceived usefulness, social influence, effort expectancy and facilitating conditions. Quantitative data was conducted on measurable variables, for example, Age of respondent, Number in Household, Number of Dairy Cattle, etc.

3.3.1. Secondary data

Data was also collected through desk review of documents from Ministry of Agriculture, Animal Industries and Fisheries and publications sourced online; relevant past theses and dissertations, organizational/institutional reports, proceedings of professional conference, journal articles, books and policy briefs from the internet. A desk review of relevant literature included information on agriculture development programs, policies, data describing the study area like demographic data, location, soil conditions and climatic conditions.

3.4 Methods of Data Collection

Data was collected using a survey in form of interview schedules. The interview schedules were administered to all the categories of participants in the dairy value chain. The interview schedule sought to ascertain the frequency of use and use behavior of ICTs plus other factors that would affect the extent of ICT use along the dairy value chain. Observation was also conducted especially at milk collection centers, and on various farms in the area. Focus group discussions were used to elicit ideas from representative groups of value chain actors. Interviews were conducted with key informants in Bulking and Cooling Centers, Cooperatives and Milk Processing Centers.

A review was conducted on existing literature in the field of ICT in agriculture, and related issues. Also, of interest was literature related to the study area (Kiruhura District) and the dairy value chain.

3.5 Methods of Data Analysis

Data was analyzed using a variety of methods appropriate for qualitative and quantitative data that was collected.

3.5.1 Quantitative data

This was analyzed using frequencies, ranges, percentages, means and averages to describe the data. In addition linear regression was applied to the data to establish how each variable affects the dependent variable. The software packages that was used are SPSS (Statistical Package for the Social Sciences) Version 20 and Stata Version 12.0. Data of different types was divided into the categories: interval, ordinal and nominal, and analyzed accordingly.

Inferential statistics were used to characterize the levels of ICT use by the actors in the dairy value chain. The statistics used are; one sample test of difference, T-test, Pearson's contingency coefficient, and regression. They helped in assessing the strength of the relationship between the independent (causal) variables, and the dependent (effect) variables.

Descriptive statistics provide a quantitative description of the data. They provide a summary of the dataset. Some measures that were used are; measures of central tendency (mean, median and mode), and measures of dispersion (variance, minimum and maximum, and skewness).

3.5.2 Econometric Model

The dependent variable is a continuous variable. Ordinary least-squares regression was carried out on the entire dairy value chain to investigate the relationship between the extent of ICT use and the independent variables in the study. Ordinary least-squares (OLS) regression is a generalized linear modelling technique that may be used to model a single response variable which has been recorded on at least an interval scale. The technique may be applied to single or multiple explanatory variables and also categorical explanatory variables that have been appropriately coded (Moutinho and Hutcheson, 2011).

The OLS regression model can be extended to include multiple explanatory variables by simply adding additional variables to the equation. A single response variable (Y), is predicted by multiple explanatory variables (X_1 to X_3).

$$\mathbf{Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3}$$

The interpretation of the parameters (**α** and **β**) from the above model is basically the same as for the simple regression model, but the relationship cannot be graphed on a single scatter plot. **α** indicates the value of Y when all vales of the explanatory variables are zero. Each **β** parameter indicates the average change in Y that is associated with a unit change in X, whilst controlling for the other explanatory variables in the model. Model-fit can be assessed through comparing deviance measures of nested models. For example, the effect of variable X_3 on Y in the model above can be calculated by comparing the nested models

$$\mathbf{Y = \alpha + \beta 1X1 + \beta 2X2 + \beta 3\ X3}$$

$$\mathbf{Y = \alpha + \beta 1X1 + \beta 2X2}$$

The change in deviance between these models indicates the effect that X_3 has on the prediction of Y when the effects of X_1 and X_2 have been accounted for (it is, therefore, the unique effect that X_3 has on Y after taking into account X_1 and X_2). The overall effect of all three explanatory variables on Y can be assessed by comparing the models

$$\mathbf{Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3}$$

$$\mathbf{Y = \alpha.}$$

The significance of the change in the deviance scores can be assessed through the calculation of the F- statistic using the equation provided above. As with the simple OLS regression, it is a simple matter to compute the R-square statistics (Moutinho and Hutcheson, 2011).

3.5.3 Qualitative data

Analysis was done on qualitative data to establish a cohesive narrative. Findings will be explained and summarized in the next section. First the data was coded and categorized. Categorization can be Inductive or Deductive. In Deductive categorization, there is a preset list of categories, while in Inductive categorization, the categories are got from recurrent themes within the responses. The frequency of occurrence of themes in the gathered data was computed and weights of importance were attached to the themes.

3.6 Definition of Variables and Hypotheses

There are two types of variables in this study; dependent and independent variables.

3.6.1 Dependent Variable

Extent of use of ICTs along the dairy value chain

It is an index of the various uses of ICT along the dairy value chain. Using the same approach as the International Telecoms Union, an index was calculated from a series of responses regarding use behavior of the ICTs. Since they are all coded with the values 0 and 1, their mean was calculated and it lies in the range of 0.00 and 1.00 for each

respondent. For this study, ICT is defined as mobile phone, radio, television and Internet. Being an interval dependent variable, Ordinary Least Squares regression will be used to investigate the relationships with the independent variable.

3.6.2 Independent Variables

Age: This is the age of the respondent and is a categorical variable measured in years. As the age category of respondents increases, then their ICT usage decreases. Thus, Age is hypothesized to affect the extent of ICTs use negatively (Carlsson *et al*, 2005). Since the African Youth charter defines a youth as any person between the ages of 15-35, this will be the first category. The next categories are 36-59 for middle age and 60 and above for older people (Laker-ojok and Kayobyo, 2013)

Gender: This is the gender of respondent and is a dummy variable with value 1 if respondent is male and 2 if respondent is female. Men are generally expected to have a greater access to ICTs than women. Thus, it is hypothesized that the likelihood of greater use is expected to increase if the respondent is male (Gillwal *et al.* , 2010).

Household Size: This is the number of people in a particular household and it is measured as a number. It is expected that increase of household size decreases the likelihood of owning the ICTs (Radio, Television, Mobile phone). Thus Household Size is hypothesized to affect the extent of ICT use negatively (Okello *et al.* , 2011).

Occupation: This is the occupation of the respondent. It is intended to categorise responses according to the level in the value chain. It is a continuous variable with 1=farmer, 2=Truck transporter, 3=other transporter, 4=bulk collection center personnel, 5=processing plant personnel, 6=Informal retailer, 7=formal retailer (shops), 8=dairy cooperative personnel 9=inputs supplier. It is expected that ICT use will be greatest in the dairy cooperatives (Bowonder *et al.*, 2005).

Education: This is the education level of the respondent and is a categorical variable measured in education levels. The education levels are: 1-Primary, 2-Secondary, 3-Tertiary, and 4-University. It is expected that the greater the number of years in school, the

greater the extent of ICT use. Thus education level is expected to affect the extent of ICT use positively (Carlsson *et al*., 2005).

Experience: This is the experience of the respondent and is a categorical variable measured in years. Generally, it is expected that age is related to experience, but the respondent might be a newcomer to the industry, despite an advanced age. It is expected that the greater the number of years in experience, the less the reliance on ICTs. Thus the experience of the respondent is hypothesized to impact the extent of ICT use negatively (Kirui and Njiraini, 2013).

Distance from collection center: This is the distance of the respondent from the milk collection center and it is measured in intervals of time (less than 30 minutes, 30 minutes to 1 hour, 1 hour to 2 hours, 2hours or more). It is expected that the greater the distance from town, the lesser the extent of ICT use. Thus distance from town is expected to affect the extent of ICT use negatively (Ramachander, 2011).

Number of dairy cows: This is a continuous variable and it measures the number of milk-producing cattle that the farmer owns. It is expected that the greater the number of cattle, the larger the income and hence the greater the extent of ICT use. This is because cost has been found to be a great hindrance to the use of ICT. Thus, Number of Dairy cows affects the extent of ICT use positively (Flores, 2003).

ICT skills. This is the ICT skill level of the respondent. It is a categorical variable and is measured on a rating scale where 1=basic skills, 2=moderate skills 3=highly proficient. It is expected that the greater the ICT skill, the greater the extent of ICT use. Thus ICT skill level is expected to affect the extent of ICT use positively (Gillwald *et al.*, 2010).

Accessibility: This is the level access of the respondent to the various ICTs. It is a categorical variable and is measured as follows: 1=no access, 2=low access, 3=medium access, 4=full access and 5=ownership. Ownership implies full access, but also the fact that they own the gadget. This is especially true in households which share an ICT like a Television or Computer. It is expected that the greater the access, the greater the extent of

ICT use. Thus accessibility is expected to affect the extent of ICT use positively (Tiwari *et al.*, 2014).

Utility. This is the purpose of the information. It is a categorical variable with values; 1=Extension, 2=Quality Control, 3=Financial Services, 4=Logistics and 5=Business Process Management. It is expected that Logistics and business management will have the greatest utility (Parikh *et al.*, 2007).

Type of information: This is the type of information exchanged; 1=Link to Link, 2=End to End, 3=Peer to Peer. It is expected that Link to link exchanges among middlemen will have the greatest amount of traffic and therefore ICT use (Parikh *et al.*, 2007)..

Perceived usefulness: This is the level of usefulness that the users think that the particular ICTs are to their line of work. It is a categorical variable with values 1-4 where 1=not useful, 2=somewhat useful, 3=moderately useful4=useful, and 5=very useful. It is expected that the more useful an ICT is perceived to be, the greater the extent to which it is used. Thus Perceived Usefulness is expected to influence extent of ICT use positively (Venkatesh *et al.*, 2003).

Timeliness: This is a categorical variable and it measures whether the received information by a particular ICT is timely or not. 1=timely, 0=not timely. It is expected that the timeliness of information will increase the extent of use of a particular ICT. Thus timeliness is expected to influence the extent of ICT use positively (Ifeanyi, 2012).

Facilitating conditions: This is a dummy variable and is the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system. It has a value of 1 if the individual is positive and 0 if the individual is negative about facilitating conditions. It is expected that the awareness of facilitating conditions will increase the extent of use of a particular ICT. Thus Facilitating conditions are expected to influence the extent of ICT use positively (Venkatesh *et al.*, 2003).

Social influence: The degree to which an individual perceives that important others believe he or she should use the new system. It has a value of 1 if the individual is positive and 0 if the individual is negative about social influence. It is expected that the anticipated

positive social influence will increase the extent of use of a particular ICT. Thus social influence is expected to influence the extent of ICT use positively (Venkatesh *et al.*, 2003).

Effort expectancy: It can also be called Complexity and is the degree of ease associated with the use of the system. It has a value of 1 if the individual is positive that it is easy to use the system and 0 if the individual does not believe that it is easy to use the system. It is expected that positively anticipated effort expectancy will increase the extent of use of a particular ICT. Thus effort expectancy is expected to influence the extent of ICT use positively (Venkatesh *et al.*, 2003).

Performance expectancy: This is a dummy variable and measures whether the respondent thinks that the ICT will improve their ability to do their work. It has a value of 1 if the performance is expected to improve, and 0 if it is not expected to improve. It is expected that if an ICT is not expected to improve performance, it will not be used. Thus performance expectancy will influence extent of ICT use positively (Venkatesh *et al.*, 2003).

Voluntariness of use: Whether the respondent actively seeks to use the ICT. This is a dummy variable with value 1 if the person actively seeks to use the ICT and 0 if the person does not. It is expected that a greater voluntariness of use will lead to a greater use of ICT. Thus voluntariness of use affects the extent of ICT use positively (Venkatesh *et al.*, 2003).

Affordability of ICT: This is whether a respondent thinks that an ICT is affordable and is a dummy variable with value 1 if it is affordable and 2 if it is not affordable. People are more likely to purchase an ICT if they view it as affordable. Thus the likelihood of greater use is expected to increase if the respondent is male (Venkatesh *et al.*, 2003).

4. RESULTS AND DISCUSSION

This chapter presents the findings of the study along with analysis and discussion of the results obtained. It organized into sections dealing with the Characteristics of the Dairy Value Chain Actors, their use of ICTs and an identification of the factors affecting the extent of ICT use with the aid of an econometric model. The scope of the finding of the study is limited to descriptive statistics, correlation analysis and econometric modelling. The Ordinary Least Squares Logistic regression analysis was used to find relationships between factors influencing the extent use of ICT in the Dairy Value Chain in Western Uganda. SPSS and Stata were used to analyze the data.

4.1. Characteristics of Dairy Value Chain Actors

4.1.1 Demographics

The sample respondents of the study were both male and female. Males were the majority and made up 86.4% while females made up 12.3 percent of the respondents. The majority of the respondents were in the age group category of Below 35, at 43.8% with 28.4% in the age group of 36-59 while 25.3% were over 60 years old. By the time of the survey, more dairy value chain actors were married (63.6%) as opposed to those who were unmarried (35.2%). Family size ranged from 1 person to 30 people. This includes extended family members like orphans from the siblings of the household head. The average family size was around seven people. The majority of dairy value chain actors are you, and at the same time, the majority are married. This implies larger households and possibly distribution of duties within the household.

In terms of education, majority (90%) of dairy value chain actors had attended some form of formal education, while only about 9% had not attended any formal education. Among those who had attended some type of formal education, around 20% said that they had only attended primary school, around 39% said that they had attained secondary school level of education, around 10% had achieved tertiary education, with 21% having attained university education.

Table 2: Demographics of Dairy Value Chain Actors

Variable	Variable Categories	Number of respondents	Percentage of respondents
Age group	below 35 years	71	43.8%
	36-59 years	50	30.9%
	above 60 years	41	25.3%
marital status	Single	57	35.2%
	Married	105	64.8%
gender of respondent	male	142	87.7%
	female	20	12.3%
have you attended any formal education	yes	148	91.4%
	No	14	8.6%
level of education	None	13	8.0%
	Primary	33	20.4%
	Secondary	66	40.7%
	Tertiary	16	9.9%
	University	34	21.0%

Source: Own Survey Data, 2016.

Family size of the respondents ranged from 1 person to 30 persons in the household. The average family size (Mean) was 6.63 people. The standard deviation was 5.571 people. This indicates that although the number of people in a family is an average of 7 people, this family size can vary by around 5 people. This implies availability of household labour to do various duties around the homestead. A study by Sikawa and Mugisha (2011) found that, the greater the number of adults in the household, the greater the likelihood of selling milk to the formal milk marketing channels. Thus, the household size in the study area, favours the formal mil marketing channel of the dairy value chain.

4.1.2 Role in the dairy value chain

Dairy value chain actors were in different categories to represent the various stages of the Dairy Value Chain. Farmers were the majority at 45.1% while Inputs Suppliers and Dairy Cooperative groups were the minority at 1.9% each. The majority of dairy value chain

participants had less than 5 years' experience (39.5%), with those who had over 10 years' experience coming in second place at 37%. Majority of the dairy value chain actors lived less than 30 minutes away from the milk collection center (46.9%). This could mean that milk collection centers have moved nearer to the farmers in a bid to ease transport costs. Another explanation could be that the farmers are using motor vehicles instead of bicycles, and hence the greater distance. The proportion of respondents decreased significantly, the further away you moved from the bulk collection centers (Table 3).

Table 3 Dairy Value Chain Actor Characteristics

Variable	Variable Categories	Count	Column N %
Occupation	Farmer	73	45.1%
	Truck transporters	8	4.9%
	Other transporter	34	21.0%
	bulk collection centre	8	4.9%
	processing plant	6	3.7%
	Informal retailer	16	9.9%
	formal retailer (shops)	11	6.8%
	Dairy Cooperative	3	1.9%
	Inputs supplier	3	1.9%
years of experience	below 5 years	64	39.5%
	5-10 years	38	23.5%
	above 10 years	60	37.0%
distance of home from collection centre	less than 30 minutes	76	46.9%
	30 minutes to 1 hour	39	24.1%
	between 1 hour and 2 hours	35	21.6%
	more than 2 hours	12	7.4%

Source: Own Survey Data, 2016.

4.2 Access and use of ICT

The ICTs that were being used by the sample respondents include Radio, Television, Mobile phones and Computers. Participants were asked about the level of access to various ICTs. The levels of access to the ICTs were as follows: No access = no access at all to the

ICT, Low access=monthly access to the ICT, Medium access=weekly access to the ICT, High access=many times a week access to the ICT, Ownership=ability to access the ICT at any time.

The overall trend was towards High ownership of radios. This is in agreement with the hypothesis that Radio is the most common ICT in rural areas in Africa. Gillwald *et al*., (2010) found that, radio is the most widely used ICT. It is also perhaps the only ICT that exists in most rural areas in Africa and is one of the main sources of information for many low income and rural households.

The next ICT considered was television. The table indicates that the majority of the respondents did not have access to a television. The trend decreases as the level of access increases. However, the proportion of the respondents with ownership of a television is higher (18.5%) than those with high access to the television (9.3%). This result, indicates that, even though they may not own it, a slight majority of people (52.5%) have access to a television set. This provides opportunities for documentaries and various farming programs to be broadcast to target audiences in the study area. However, it was found that there is a lack of locally oriented content that is relevant to the dairy farmers in the study area. This is also evidenced by the availability of only one television station (TV West) that is in the local dialect and occasionally has dairy farming related programming.

The next ICT for consideration was the mobile phone. The great majority of respondents had ownership (64.8%) or high access (29.6%) to a mobile phone. This is in line with various findings that suggest that mobile phones are the most popular ICT in the developing world (Deen-swarray *et al*. 2012). It is also further evidence of the rapid spread of mobile telecommunication networks in Africa, and an opportunity to facilitate technological adoption via ICT-based extension programs (Aker *et al.*, 2011). The existence of a high number of mobile phones opens up a number of opportunities for innovations to be designed for rural communities (Asenso-okyere and Mekonnen, 2012).

The last ICT considered was the computer. This is because ICTs such as the Internet, networked computers, mobile phones, and smart phones are the latest in a long line of technologies (the newspaper, telegraph, telephone, radio, and television) that support risk

management practices by collecting, processing, distributing, and exchanging information (World Bank, 2011c)

The overall trend of access to a computer is skewed towards ownership of a computer. However, the majority of respondents had no access to a computer, at 66%. This is similar to findings that suggest that computers would be the least accessible due to the high costs involved (Dorai and Reddy, 2011). There is also the problem of lack of skilled users of ICT, which is in line with the findings of Gelb and Parker (2005). Of interest is the fact that most businesses, including Amos and Pearl dairies were in ownership of at least one computer. All the bulking and cooling centres operated computerized coolers. The findings are summarized in Table 4.

Table 4. Levels of Access to ICT by percentage

		Levels of access to ICTs (%)				
		No access	Low Access	Medium Access	High Access	Ownership
ICTs	Radio	13.6	5.6	12.3	17.9	50.6
	Television	47.5	11.7	13.0	9.3	18.5
	Mobile Phone	1.9	1.2	2.5	29.6	64.8
	Computer	66.0	7.4	5.6	6.8	14.2

Source: Own Survey Data, 2016.

4.3 Use of ICT and Information Flows

The ICTs have many applications in agriculture, but these have been summarized into six main categories. The respondents were asked about their use of the ICTs in relation to the six main uses of ICT. The first ICT to be considered is radio. From the earlier results, radio, along with the mobile phone is the most popular ICT. This means that the observed results carry more weight than the other 2 ICTs.

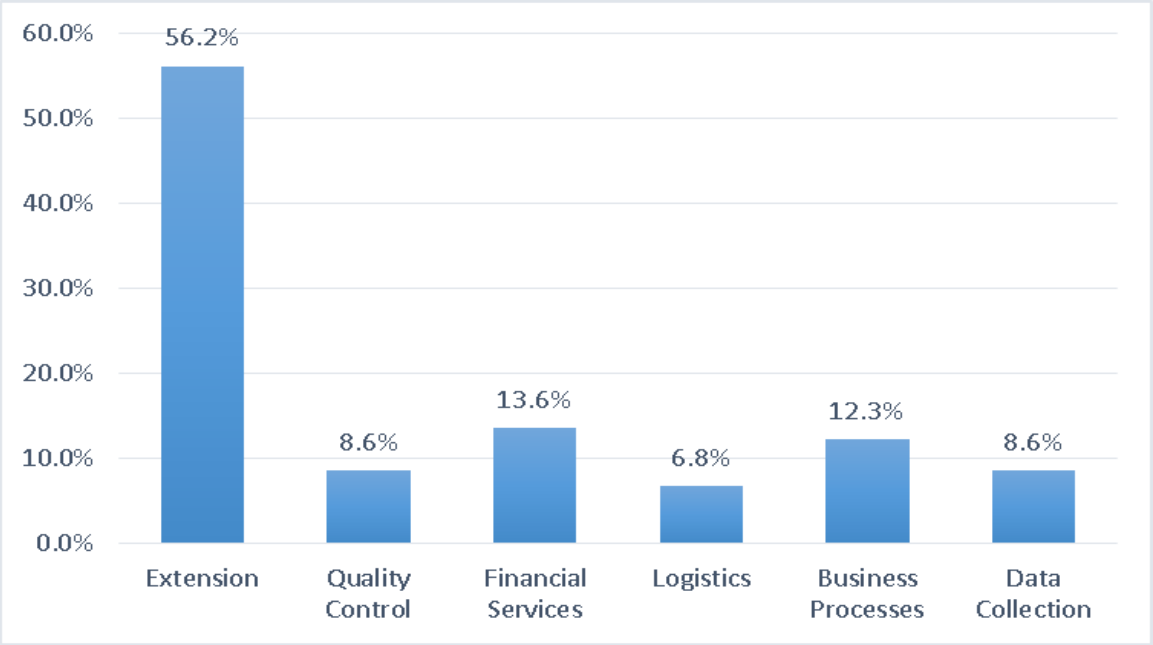

Figure 11. Uses of Radio by percentage. Source: Own Survey Data, 2016.

As can be seen from the figure above, most of the use of radio was for Extension. This is due to the presence of a local radio station that is in the local language (Runyankole) and has agricultural programmes on dairy production. An emphasis is given to dairy production radio programmes because the main activity in Kiruhura district is Dairy farming (Sikawa and Mugisha, 2011). Input providers such as veterinary products suppliers, veterinary doctors, banking and financial services, and dairy cooperatives also reported paying for advertising at the local radio station.

The next ICT under consideration is television. From the results above, the slight majority of respondents have access to a television, though only about 18% own a television. Farmers were asked about the use of a television for the six uses in the agriculture value chain. However, most of the farmers report that they use television for entertainment purposes mainly. This is because there is only one regional television (TV West) that is able to cater to farmer needs in the local language. One key informant also noted that, being a remote area, and with the analog to digital television migration, television access is mainly through DSTv, as a satellite based television is the only way to get television signals. The other players in this satellite television space are Zuku TV and Azam TV.

Other farmers, when asked in the interview schedule, about other sources of information, reported that they access documentaries on computer and television.

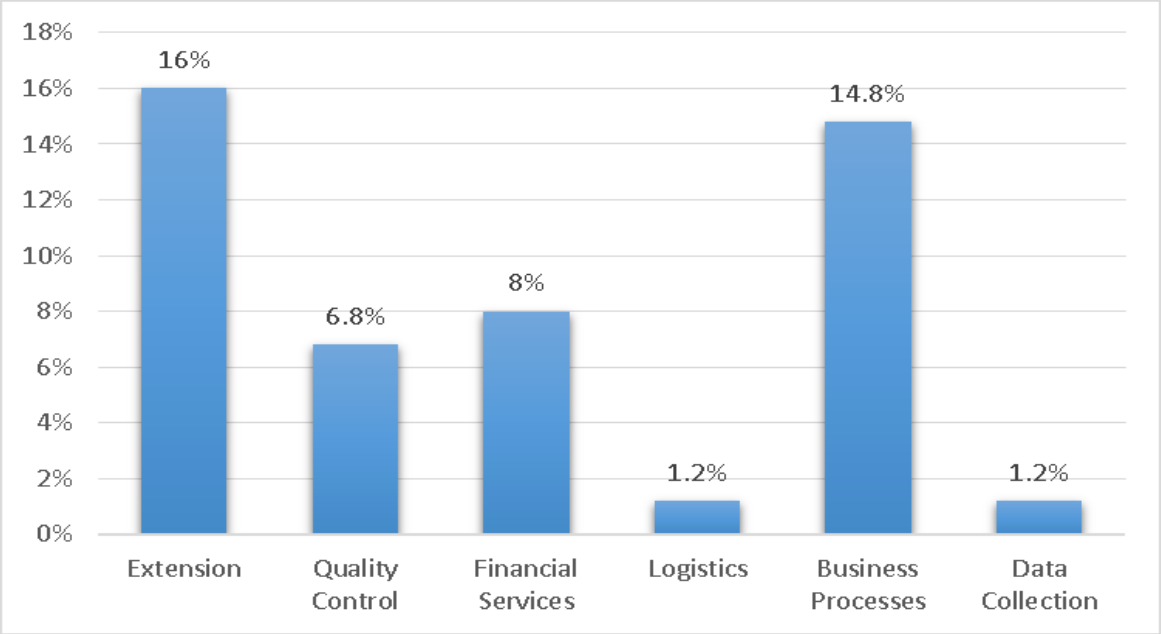

Figure 12. Uses of Television by percentage. Source: Own Survey Data, 2016.

The biggest uses of television were for extension and for business processes. Business processes were defined, for the purposes of this study, as any activities that support the smooth running of a business. This includes accounting, stock management, customer relationship management and payroll. The farmers accessed various television programmes as relates to dairy farming and also commodity prices regionally and countrywinde. This is to be expected as television sets are costly, but also television does not have enough television programmes related to agriculture in general and agriculture in particular.

The next ICT under consideration is the mobile phone. It is the most popular ICT and has the majority of respondents either owning or having access to one, as indicated in Table 4 above. Due to this, many innovations have been made to enable productive uses of mobile phones, such as mobile money, mobile internet, e-extension by SMS and a variety of other products. Mobile money is useful to farmers especially, as it helps them to keep and manage money on their phone for security and records purposes. It also enables automated payouts frombulk milk collectors to farmers, although this was not observed to be the case in the study area. In the cooling centers, farmers had a record book that was signed by the

manager and the farmer to show successful acceptance of good quality milk. This was the record used for payments processing. Mobile internet would be useful to all the actors in the dairy value chain, as it would provide a rich source of information for whatever question they may have. This would include milk prices in Kampala, some 240 km away, also, farming and milk preservation practices. Mobile internet would also enable the businesses to leverage other communication tools like Whatsapp in order to enhance interactivity with their clients. E-extension is very limited int eh study area, and is accessed by few farmers. The organisations providing the e-extension services are in the urban centers of Mbarara and Kampala. There was no report of government e-extension services in the area. This is an area that needs improvement. However, the most popular form of communication is voice messaging, and this is due to the low learning curve as relates to making calls, and the ability to offer meaningful two-way communicationn at a relatively cheap cost. Issues of literacy also affect users with around 30% of respondents having primary education, or none at all(Table 2). This means that SMS has to give way to the easier voice calls.

Figure 13. Uses of Mobile Phone by percentage Source: Own Survey Data, 2016.

Logistics involves the coordination of movement of goods and services along the supply chain (Gooch and Felfel, 2008; Sen and Choudhary, 2009)The mobile phone, being a cheap source of two-way communication, enables effective and timely coordination of movement of goods and services . However, one of the key challenges noted was that of

poor network coverage. Farmers noted that the phone network is only found in some areas on their farms and in their homesteads. This leads them to rely more on the radio for information whenever they are out of range of the mobile telecommunication network. Around 38% of farmers use the telephone in their business processes. This is due to mobile phones becoming cheaper, yet more powerful at the same time. The average smartphone today can conduct basic calculations and store them in a spreadsheet. Thus, dairy value chain actors are using their mobile phones more and more to perform basic record keeping.

The next ICT under consideration was the computer. It was not asked whether those who possess computers are connected to the internet. This is because, the average smartphone user has no need to connect to the internet for basic browsing. The computers in use were mainly for entertainment at home, or record keeping in business premises. This is especially true of dairy cooperative societies who keep an assortment of records on their farmers. The information gathered is shown in Figure 14 below.

Figure 14. Uses of computers by percentage. Source: Own Survey Data, 2016.

The biggest uses of the computer were for Quality control (14.2%), Business processes (13.6%) and Data collection (19.1%). In quality control, all the bulking and processing centers used computerized coolers. The computers keep the refrigeration unit running at optimum temperatures for preservation of milk quality for transportation. Businesses also use computers for inventory management and control, and to keep a record of their

customers. Data collection is for customer data, stock data, milk price information and knowledge management related to the business. This is indicative of the growing use of computers for business in rural areas in Uganda.

4.4 Information flows and Information Preference

Survey respondents were also asked about the information flows they most commonly use their ICTs for. The information flows were: coordination of products along the dairy value chain, knowledge and experience sharing with colleagues and getting feedback between producers and consumers. The results are as indicated in Figure 15.

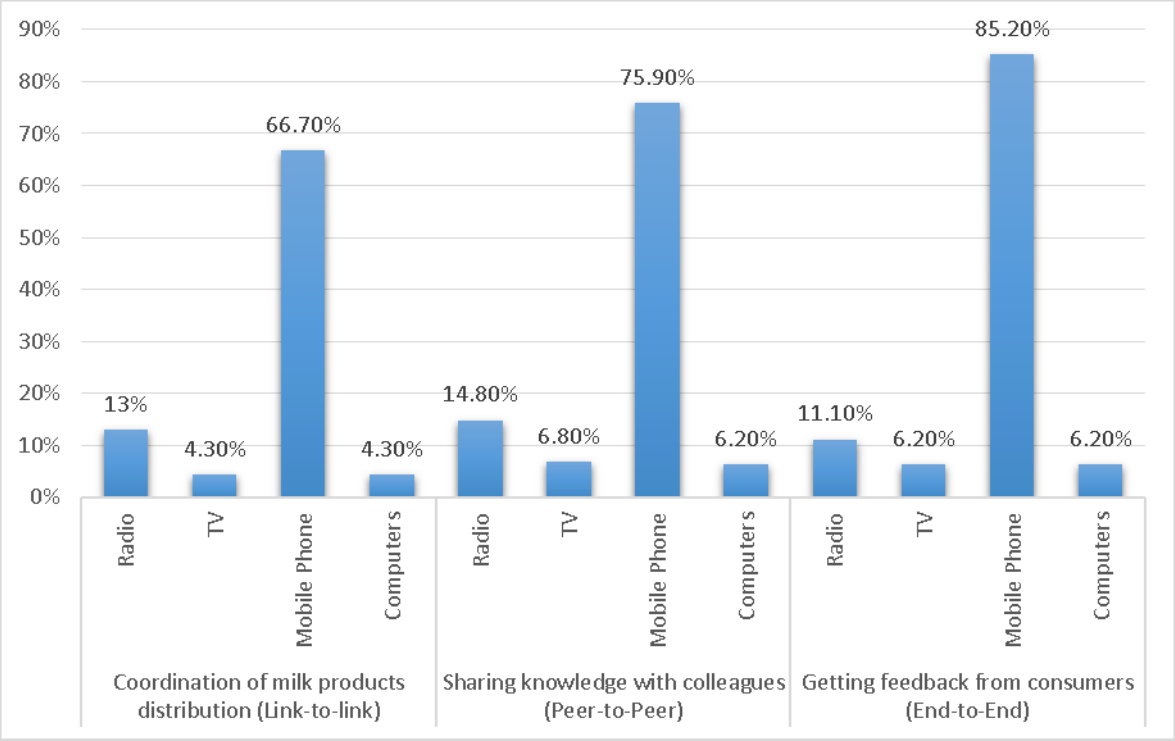

Figure 15: Typology of information flows Source: Own Survey Data, 2016.

Figure 15 indicates that the mobile phone is the most popular in all the kinds of information flows along the value chain, with radio coming in a distant second and television and computers, relatively similar in percentage across all the categories. This once again highlights the importance of mobile phones to the dairy value chain.

4.5 Challenges facing the adoption of ICTs along the dairy value chain

Respondents were asked to identify the challenges to use of technology. Key informants, two focus groups and individuals were asked about the challenges facing the adoption of the four ICTs mentioned above. The responses were then recorded for purposes of discussion.

The two focus groups were in Kashongi and Kazo. Twelve transporters, both of vehicles and bicycles were asked about the challenges facing the use of ICTs in Kashongi sub-county. In Kazo sub-county, fourteen farmers were asked about the challenges facing the use of ICT. The focus group discussion checklist is found in Appendix 5. It is usually recommended that four or more focus group discussions are conducted. However, due to information saturation from the Interview Schedule (Appendix 4, question 34), it was deemed unnecessary to conduct any more. Responses from the survey were tallied and the results are given below.

The most common challenge was the costs associated with the purchase, and the use of ICTs. This was reported by 34 respondents. Due to Televisions and Computers were deemed not affordable by many people, they became the least prevalent ICTs in the region. There is lack of terrestrial television coverage in the area, leading to the necessity for the more costly satellite television access by companies like DSTV, Zuku TV and Azam TV. Costs associated with using the ICTs, such as cost of internet connection, cost of airtime, cost of mobile phone charging and cost of batteries also affected the adoption and use of the ICTs.

Second, wrong information was another challenge facing the dairy value chain actors. This was reported by 33 respondents. This could be wrong information on prices, agricultural practices, milk preservation practices, or biased information. This led to skepticism on the part of respondents for some of the ICTs, especially Television. However, key informants revealed that documentaries and video shows in the area are valuable sources of agricultural information.

Communication network coverage is also a big challenge. Radio Five in Rushere parish has limited coverage, and yet it is a source of most of the local agricultural information. 33 respondents cited this as a challenge. The mobile phone network also has poor coverage in some areas, leading to reliability more on radio than on telephone. This hampers coordination efforts, especially as regards the distribution of milk products. Since farmers also fail to make or receive calls, they cannot share knowledge and information with each other, leading to a bigger information divide in the region.

Information obtained was also unreliable. Thirty respondents reported this challenge. Milk prices often took months to be changed on information portals, yet on the ground, milk prices change more frequently. The quality of information received in some instances was also reported as being poor. This leads to people relying on multiple sources of information, not just 1 or 2 ICTs.

Some respondents (21 respondents) also had a challenge interpreting the information provided. This could be attributed in part to high levels of illiteracy in the region. Thus, SMS information was wasted on such respondents. Another challenge in interpretation was the language barrier. Information was sometimes obtained in a language that was hard for respondents to understand, like English, yet the local language would serve such people well.

Lack of skills also affected the use of some ICTs. Twenty people cited this as a challenge. This led to people shunning the use of these ICTs. The most commonly cited example ICT was the computer. Respondents expressed a desire for more ICT training in order to be able to use computers, but training centers were few in the area. Respondents said that they were more inclined to use an ICT is they found it easy to use, such as the mobile phone. However, they lacked training on maximizing the benefits of connectivity through mobile phone.

The next response (17 respondents) was lack of electricity. This is in varying degrees. The villagers have limited or no access to electricity infrastructure while the residents of urban centers have the infrastructure, but are limited by an unreliable power supply. As a result, many businesses have to use generators in order to run without interruption. This makes

business costs go up; a cost which is passed on to the consumer. Bulk collecting and cooling centers have to run more powerful generators in order to preserve milk quality.

The mobile money network was also a challenge. Sixteen respondents cited this as a challenge. Sometimes the network would go off, or delay transactions for a long time, leading to delays in business transactions. In a country where banking services are low and mobile money transactions are high (USAID, 2013), this seriously hampers businesses in the lesser banked rural areas.

A lack of repair centers means that if a gadget is spoilt, it will take a long while to be fixed, and the costs are likely to be prohibitive. This is because of transport costs to the next major town. Nine users gave this as a challenge for ICT adoption.

4.6 The Extent of ICT use along the dairy value chain

Respondents were asked a variety of questions regarding the use of ICTs along the dairy value chain. Data in the categories that indicated the use of the various ICTs was summed up to give a cumulative score of ICT use. An index was created by dividing the number of obtained favorable responses by the maximum positive responses observed. This is an index that expresses the extent of ICT use of a participant in the study. According to Anderson (2008), a summary index is a weighted mean of several standardized outcomes. The weights are calculated to maximize the amount of information captured in the index. Since all the variables used in calculating the index of extent of use require “yes” or “no” responses, they all have equal weight. The ICT use sub-index is a component of the ICT development index and is designed to capture intensity (ITU, 2014). However, this index is not suitable for the current study as it captures information outside the scope of this study, one indicator being Wireless broadband subscriptions per 100 inhabitants.

The descriptive statistics for extent of use are in the histogram in Figure 16

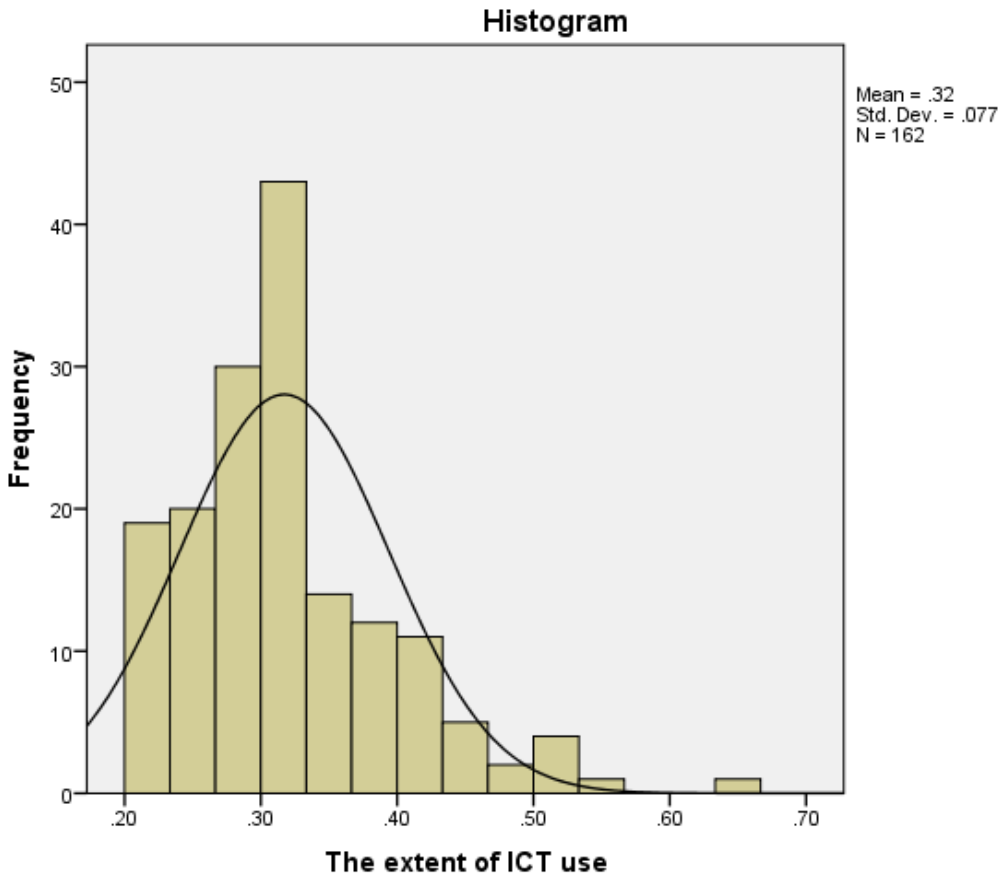

Figure 16 Histogram showing extent of use of ICTs among the respondents

The mean value of extent of use is 0.32 indicating a generally low extent of use among the respondents. From the histogram above, we can see that the data of sampled respondents is skewed towards the lower end of the extent of ICT use spectrum. This also indicates a generally low extent of ICT use along the dairy value chain in Kiruhura district, Western Uganda.

4.6.1 Extent of ICT use along the dairy value chain

This was done by calculating the mean index value of Extent of ICT along each occupation in the dairy value chain. The results obtained are shown in the following figure.

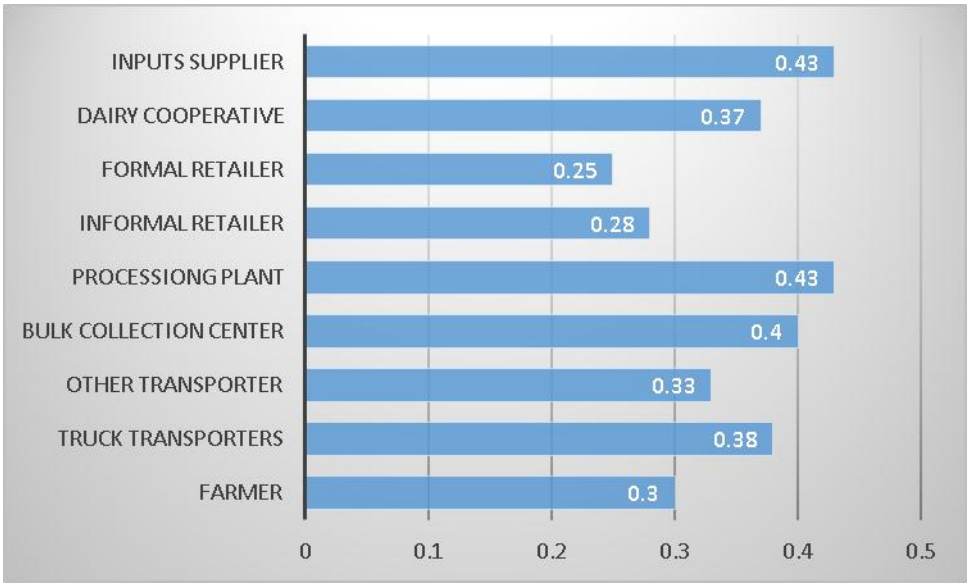

Figure 17: The Extent of ICT use at various levels of the dairy value chain. The scores are based on the Extent of ICT use index. Source: Own Survey Data, 2016.

This shows that the average Extent of ICT along each value chain category is less than 0.5. The highest values are found among inputs suppliers and Processing plants. This is because they need to communicate with a greater number of people, and also need to utilise more technology to run an efficient business.

4.6.2 Econometric regression of extent of ICT use along the dairy value chain in Western Uganda

An Ordinary Least Squares (OLS) regression was carried out in order to determine relationships between the variables. Heteroscedasticity was found in the data, meaning that the variance wasn't constant. To fix this, robust statistical methods were applied to the data. VIF (Variance inflation factor) values were then calculated for the independent variables to check for multicollinearity, and since none was found to be above 10, the regression results were accepted. A contingency coefficient matrix for the categorical variables and VIF for the interval variables was obtained, and no multicollinearity was detected. Table 5 presents results from the model.

Table 5. Results of OLS Regression on Extent of ICT use along the Dairy Value Chain

EXTENTICTSCALE	Coef.	Robust Std. Err.	t
SKILL	-.0672623	.082621	-0.81
USEFULNESS	.175827	.0585776	3.00***
ACCESSIBILITY	.0604386	.0472566	1.28
AFFORDABILITY	.0125933	.1703668	0.07
INFOSEEK	.1835992	.0958732	1.92*
JOBPERF	.3305163	.1731272	1.91*
EASE	.1200869	.1902163	0.63
IMPORTANCE	.1884789	.0663851	2.84**
INFRASTRUCTURE	-.0484396	.0558878	-0.87
TIMELY_INFO	-.0314011	.0580834	-0.54
AGE_GP			
2	-.0385248	.0794352	-0.48
3	-.1340183	.0949247	-1.41
MSTATUS	-.0802046	.0778511	-1.03
GENDER	.0145664	.0626828	0.23
LEVEL			
1	.0293236	.0732169	0.40
2	-.0394595	.0897588	-0.44
3	-.0955484	.1298352	-0.74
4	.0139079	.1035007	0.13
FSIZE	.013148	.0098716	1.33
OCCUPATION			
2	.3968354	.1541101	2.58**
3	.1777221	.0751835	2.36**
4	.4031294	.1678824	2.40**
5	.5416148	.2571554	2.11**
6	.055321	.1007982	0.55
7	-.0450715	.0953056	-0.47
8	.1047764	.2176495	0.48

9	1.040453	.1095815	9.49
EXPERIENCE			
2	-.1343428	.0712092	-1.89*
3	.0302617	.0620837	0.49
DISTANCE			
2	-.0205864	.0691975	-0.30
3	-.0517089	.0616351	-0.84
4	.010252	.1328471	0.08
_CONS	1.54721	.2039972	7.58
NUMBER OF OBS=162			
F(32, 129) =25.40			
PROB > F=0.0000			
R-SQUARED=0.5449			
ROOT MSE=.29099			

Source: Own estimation result, 2016, ***,** and * means significance at the 1%, 5% and 10% probability levels, respectively.

4.6.3 Discussion of Econometric Model Results

From the results of the OLS regression, it was found that Perceived Usefulness (USEFUL), Voluntariness of use(INFOSEEK) , Performance expectancy(JOBPERF), Social Influence (IMPORTANCE), Number of transporters, Bulk Collectors, and Inputs supplier (OCCUPATION 2,3,4,5) influenced the Extent of ICT use positively while Number of actors with experience of 5-10 years (EXPERIENCE, 2) influenced the Extent of ICT use negatively.

Perceived usefulness is the level of usefulness of an ICT to the line of work of the respondent. It was found that perceived usefulness has a positive impact on the Extent of ICT. This agrees with hypothesis and findings of previous studies (Hassan *et al.*, 2011; Venkatesh *et al*., 2003). Another study found that businesses are more likely to increase the use of an ICT as they perceive it to be an advantage (Khayati and Zouaoui, 2013). The

coeffiecient of Perceived Usefulness is 0.175827, meaning that, for every unit increase in Perceived Usefulness (USEFUL), the extent of ICT goes up by 0.175827 units, holding all other variables constant.

Voluntariness of use is whether the respondent actively seeks to use the ICT. It was hypothesized to have a positive effect on the use of ICT, and thus the extent of ICT use. This agrees with the findings and is in line with Venkatesh *et al* (2003) who formed the UTAUT model in order to unify the various adoption theories in the Information sciences. The coefficient for Voluntariness of use is 0.1835992. For every unit increase in Voluntariness of use (INFOSEEK), the extent of ICT goes up by 0.1835992, holding all other variables constant.

Respondents were expected to use a technology more if they perceived that it improved their performance on the job. The results from the model show that the positive coefficient means that Performance Expectancy has a positive influence on the extent of ICT use. This is in line with previous studies as expressed above. The coefficient for Performane Expectancy is 0.3305163. For every unit increase in Performance Expectancy (JOBPERF), the extent of ICT goes up by 0.3305163, holding all other variables constant.

Social influence was also theorized by Venkatesh *et al* (2003) to have a positive impact on the adoption of a technology. A person is more likely to adopt a technology if it is deemed important in the society. The OLS regression results agree with this hypothesis and previous studies by Venkatesh (2003) and others. The coefficient for Social influence is 0.1884789. For every unit increase in Social influence (IMPORTANCE), the extent of ICT goes up by 0.1884789, holding all other variables constant.

The occupations that had an impact on the extent of ICT use were; transporters, bulk collectors, processing plants and inputs suppliers. This is due to the fact that they have to do a lot of telecommunication in order to stay informed and mitigate business risks (World Bank, 2011a). The coefficient for Transporters (OCCUPATION, 2) is 0.3968354. For every unit increase in Transporters, the extent of ICT goes up by 0.3968354, holding all other variables constant. The coefficient for Bulk Collectors (OCCUPATION, 3) is 0.1777221. For every unit increase in Bulk Collectors, the extent of ICT goes up by

0.1777221, holding all other variables constant. The coefficient for Inputs Suppliers (OCCUPATION, 4) is 0.4031294. For every unit increase in Inputs Suppliers, the extent of ICT goes up by 0.4031294, holding all other variables constant. The coefficient for Inputs Suppliers (OCCUPATION, 5) is 0.5416148. For every unit increase in Inputs Suppliers, the extent of ICT goes up by 0.3968354, holding all other variables constant.

Experience in the 5-10 year range had a negative impact on ICT use. This agrees with findings from other studies that found that ICT use decreases as age increases (Carlsson *et al*., 2005). The coefficient for Experience in the 5-10 year range (EXPERIENCE, 2) is -0.1343428. For every unit increase in Experience in the 5-10 year range, the extent of ICT goes down by 0.1343428, holding all other variables constant.

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary

The study was carried out in Kiruhura District, Western Uganda, It is located in the cattle corridor of Uganda. The main economic activity is dairy farming as it is economically profitable and the soils are less suitable for cropping systems. The district produces approximately 100,000 liters of milk per day. Four sub counties were randomly chosen, and then random sampling was done on the defined population of Dairy Value Chain actors. This study sought to find the extent of ICT use along the dairy value chain. Primary and secondary data were collected using pretested interview schedules, and desk research of all relevant documents. Quantitative Data was analyzed using descriptive statistics to characterize the population and inferential statistics to characterize the level of ICT use in the dairy value chain. Regression was used to identify the challenges facing ICT use in the study area. Qualitative data was analyzed by content analysis.

The mobile phone was found to be the most common ICT used by all the actors along the dairy value chain. This was followed by the radio. Both of these items were deemed affordable by the majority of respondents as opposed to computers and televisions. While there was a high rate of television access and ownership, many respondents reported that the television was mainly used for entertainment purposes.

From the OLS regression, it was found that Perceived usefulness, Voluntariness of use, Performance Expectancy, Social Influence, some occupations, and Experience in the 5-10 year range had a significant relationship with the extent of ICT use along the dairy value chain. Experience in the 5-10 year range had a negative relationship with the dependent variable while some occupations, Voluntariness of use, social influence, performance expectancy and perceived usefulness had positive relationship with the dependent variable.

5.2. Conclusion and recommendations

There is a low extent of ICT use along the dairy value chain. While mobile phones have the required ecosystem, there is still a very low extent of innovation in the dairy value

chain. This is evidenced by the lack of dairy chain-specific mobile innovations. This is despite the availability of mobile money, and the affordability of some smartphones. There remains a lot to be done in this area.

In the case of infrastructure, respondents reported that telecommunication networks have a limited coverage in some of the deeper villages. This should be addressed by the telecommunication companies putting up more telephone masts in the area. However, the cost of masts is prohibitive, due to the amount of money required to keep each individual mast active in the frequent power outages. To this end, the government should invest in upgrading the power production in the country.

There is only one radio station in the area that is specifically catering to the local population. This limits the variety of programs that can be accessed by the farmers. However, most farmers preferred radio because it delivers more meaningful information over a longer period of time than the other ICTs. Radio can be coupled with mobile phones for maximizing the effectiveness of the agricultural programs that are broadcast in the district. Radio is also preferred by farmers who are outdoors most of the time, and provides both entertainment and information.

Computers have the lowest extent of use, partly because of perceived complexity by the bigger sections of the dairy value chain (farmers and transporters), and also due to perceived lack of affordability. However, most of the businesses in the value chain owned computerized coolers as they were vital for Business processes, Data collection and Quality control. Lack of computer skills also affected the extent of use of computers. To this end, respondents urged the government to increase ICT training centers in the region.

Illiteracy was another problem faced by respondents who could not read received SMS (Short Messaging Service) messages on phone. The government can increase on the number of Adult Learning Centers in the rural areas. This is due to higher illiteracy levels in the countryside.

Government can also reduce taxes on airtime and mobile phones. Uganda has one of the highest tax regimes on airtime and mobile phones in East Africa, with the lowest per

capita income (Ndiwalana and Tusubira, 2012) This would stimulate growth in the telecommunications sector, which is already one of the more vibrant sectors of the economy.

Further research is needed to describe more clearly the nature of use of each ICT by the dairy value chain actors, changing perceptions towards affordability as cheaper and cheaper ICTs emerge, changing perceptions towards usability as more applications for business are made available to smartphones, and maximizing the efficiency of the dairy value chain in order to minimize delays and reduce risk of spoilage of milk products.

6. REFERENCES

Adebambo, S., and Toyin, A. 2011. Analysis of Information and Communication Technologies (ICT) Usage on Logistics Activities of Manufacturing Companies in Southwestern Nigeria. *Emerging Trends in Economics and Management Sciences*, *2*(1), 68–74.

Agriterra. 2012. Identification of livestock investment opportunities in Uganda Identification of livestock investment opportunities in Uganda.

Aker, J. C., Dethier, J., Mbiti, I., Sadoulet, E., and Lybbert, T. J. 2011. Dial " A " for Agriculture: A Review of Information and Communication Technologies for Agricultural Extension in Developing Countries. *Africa*, (March), 1–37. doi:10.1111/j.1574-0862.2011.00545.x

Ali, A., and Frew, A. J. 2013. *Information and Communication Technologies for Sustainable Tourism*.

Anderson, M. L. 2008. Multiple Inference and Gender Differences in the Effects of Early Intervention : A reevaluation of the Abecedarian, Perry Preschool, and Early Training Projects. *Journal of the American Statistical Association*, 1481–1495.

Asenso-okyere, K., and Mekonnen, D. A. 2012. The Importance of ICTs in the Provision of Information for Improving Agricultural Productivity and Rural Incomes in Africa, (January).

Balikowa, D. 2011. A Review of Uganda's Dairy Industry.

Bowonder, B., Raghu Prasad, B. R., and Kotla, A. 2005. ICT application in a dairy industry: The e-experience of Amul. *International Journal of Services Technology and Management*, *6*(3-5), 241–265.

Brugger, F. 2011. Mobile Applications in Agriculture. *Syngenta Foundation*, 1–38.

Byrnes, R. M. 1992). *Uganda: A Country Study*.

Carlsson, C., Hyvönen, K., Repo, P., and Walden, P. 2005. Asynchronous Adoption Patterns of Mobile Services, *00*(C), 1–10.

Choudhry, V., Van Engelen, A., Sebadduka, S., and Valdivia, P. 2011. *Uganda Dairy Supply Chain Risk Assessment*. *World Bank Institute Working Paper* (Vol. 25).

Deen-swarray, M., Gillwald, A., and Morrell, A. 2012. Lifting the veil on ICT gender indicators in Africa.

Deloitte. 2012. eTransform Africa : Agriculture Sector Study Sector Assessment and

Opportunities for ICT.

Dorai, K., and Reddy, V. 2011. 2011 Discussion Paper 16 Necessary but not sufficient: Information and Communication Technology and its role in putting research into use. *Technology*, (June).

Food and Agriculture Organization of the United Nations (FAO). 2013. Review of Food and Agricultural Policies in Uganda 2005-2011 Review of Food and Agricultural Policies in Uganda 2005-2011, (February).

Flores, C. 2003. Measuring the relationship between ICT use and income inequality in Chile By.

Forman, C., and Goldfarb, A. 2006. Diffusion of information and communication technologies to businesses.

Frederick, S., and Gereffi, G. 2004. Value Chain Governance. *Development Policy Review*, *21*(3), 333–625. doi:10.1111/j.1467-8659.2003.00227.x

Gelb, E., and Parker, C. 2005. Is ICT Adoption for Agriculture Still an Important Issue ? *Environment*, 1–8.

Gillwald, A., Milek, A., and Stork, C. 2010. Gender Assessment of ICT Access and Usage in Africa. *Policy*, *1*, 1–39.

Gooch, M., and Felfel, A. 2008. *Characterizing the Ideal Model of Value Chain Management and Barriers to its Implementation*. *The Value Chain Management Centre*.

Haggblade, S., and Theriault, V. 2012. A Conceptual Framework for Promoting Inclusive Agricultural Value Chains. *Small*, (November), 0–37.

Halewood, N. J., and Surya, P. 2012. Mobilizing the Agricultural Value Chain. *Chapter 2 in Information and Communications for Development*, 31–44.

Hassan, M. A., Samah, B. A., Shaffril, H. M., and D'Silva, J. L. 2011. Perceived usefulness of ICT usage among JKKK members in Peninsular Malaysia. *Asian Social Science*, *7*(10), 255–266. doi:10.5539/ass.v7n10p255

Heeks, R., and Molla, A. 2009. Compendium on Impact Assessment of ICT-for-Development Projects.

Ifeanyi, A. 2012. The impact of Information and Communication Technology (ICT) on News Processing , Reporting and Dissemination on Broadcast stations in Lagos , Nigeria.

International Institute for Communication and Development IICD. 2014. ICT Solutions for

Inclusive Agricultural Value Chains, (May).

ITU. 2013. *International Telecom Union Annual Report 2013: Measuring the Information Society*.

Kahenya, D. W., Sakwa, M., and Iravo, M. 2014. Assessing Use of Information Communication Technologies among Agricultural Extension Workers in Kenya Using Modified UTAUT Model, *4531*, 11–22.

Kamugungunu, P. 2012. *The Republic of Uganda, Kiruhura District Local Government. Kiruhuhura District Local Government Abstract*.

Kaplinsky, R., and Morris, M. 2000. A handbook for Value Chains. An Important Health Warning or A Guide for Using this Handbook, (September).

Khayati, S., and Zouaoui, S. K. 2013. Perceived Usefulness and Use of Information Technology : the Moderating Influences of the Dependence of a Subcontractor towards His Contractor, 3(6), 1–28.

Kirui, O. K., and Njiraini, G. W. 2013. Conference of AAAE. Diar Lemdina Hotel – Hammamet, Tunisia September 22-25, 2013. 1.

Kivunike, F. N., Ekenberg, L., and Danielson, M. 2013. Developing criteria for the evaluation of the ICT contribution to social and economic development Developing criteria for the evaluation of the ICT contribution to social and economic development, 1–24.

Kuma, B. 2012. *Market Access and Value Chain Analysis of Dairy Industry in Ethiopia : The Case of Wolaita Zone A Dissertation Submitted to the School of Agricultural Economics and Agribusiness , School of Graduate Studies , In Partial Fulfillm*.

Kumar, R. 2014. Dairy Supply Chain Management (DSCM) Practices : An Imperative Solicitation, *1*(2), 17–24. doi:10.12966/ajnfs.04.01.2014

Kyeyamwa, H. 2008. Raising offtake from cattle grazed on natural rangelands in sub-Saharan Africa: a transaction cost economics approach.

Lagu, C., Mutaka, R. N., Oluka, J., Byenkya, S., and Ayoo, B. L. 2006. The Growth Performance Evaluation of Cattle Breeds in the South Western Agro-Ecological Zone (SWAEZ) of Uganda.

Laker-ojok, R., and Kayobyo, G. 2013. *An Impact Assessment of Opportunity International ' s Agricultural Lending Program in Uganda , Malawi , and Ghana Project Title : " Financial Services for Rural Communities and Smallholder Farmers in Africa " A project funded by The MasterCard Foundation*.

Lama, M., Mcevoy, A., Parker, S., and Robbins, K. 2014. An Analysis of Market Systems

Approaches to Agricultural Development in Uganda and Tanzania GWU Capstone Report.

Larsen, K., Kim, R., and Theus, F. 2009. *Agribusiness and innovation systems in Africa*. *Agriculture and Rural Development*. doi:10.1596/978-0-8213-7944-8

Lemma, T. T., Puskur, R., Hoekstra, D., and Tegegne, A. 2010. *Commercializing dairy and forage systems in Ethiopia : An innovation systems perspective Commercializing dairy and forage systems* (No. 17).

Levi, M., Naveh, G., Berman, S., Fink, L., Altmann, W., Leber, M., and Weber, C. 2012. Collaborative Manufacturing Network for Competitive Advantage D9 . 1 – Evaluation Framework (public), 1–26.

Marcelle, G. M. 2000. Transforming Information and Communications Technologies for Gender Equality, (May).

Martin, B. L. 2010. Mobile phones and rural livelihoods : An exploration of mobile phone diffusion , uses , and perceived impacts of uses among small- to medium-size farm holders in Kamuli District , Uganda.

Masuki, K., Kamugisha, R., and Mowo, J. 2010. Role of mobile phones in improving communication and information delivery for agricultural development: Lessons from South Western Uganda. *ICT and Development - Research Voices from Africa. International Federation for Information Processing (IFIP), Technical Commission 9 – Relationship Between Computers and Society. Workshop at Makerere University, Uganda. 22-23 March 2010*, (March), 1–13.

May, J., Karugia, J., and Ndokweni, M. 2007. Information and communication technologies and agricultural development in Sub-Saharan Africa: Transformation and employment generation. *Final Framework Paper …*.

Moutinho, L., and Hutcheson, G. 2011. Ordinary least-squares regression. In *The SAGE Dictionary of Quantitative Management Research* (pp. 224–228).

Mutonyi, H., and Norton, B. 2007. ICT on the Margins: Lessons for Ugandan Education. *Language and Education*, *21*(3), 264–270. doi:10.2167/le751.0

Ndiwalana, A., and Tusubira, F. F. 2012. *What is happening in ICT in Uganda*. *Evidence for ICT policy Action* (Vol. 8).

Nkwasibwe, A. 2014. Determinants of choice of milk marketing channels by dairy farmers in Kiruhura District, Uganda.

Odele, C. 2006.Dairy Sus Sector Study Report: Soroti and Kumi districts, Eastern Uganda. (June).

Okello, J. J., Kirui, O., Njiraini, G. W., and Gitonga, Z. 2011. Drivers of use of information and communication technologies by farm households: The case of smallholder farmers in Kenya. *Journal of Agricultural Economics*

Okidi-lating, P. 2013. Leveraging Mobile Platform Technology to Address the Information and Developmental Needs of Marginalized Communities in Uganda, *7*(1), 33–41.

Parikh, T. S., Patel, N., and Schwartzman, Y. 2007. A survey of information systems reaching small producers in global agricultural value chains. *2007 International Conference on Information and Communication Technologies and Development, ICTD 2007*. doi:10.1109/ICTD.2007.4937421

Polak, P., Kuhlman, K., and Covarrubias, C. 2008. Feasibility trip for the affordable small farm UV Milk sterilizer.Unpublished Report.

Ramachander, S. 2011. The Price Sensitivitdy of Mobile Use Among Low Income Households in Six Countries of Asia. *6th Communication Policy Research South …*.

Rashid, A., and Elder, L. 2009. Mobile phones and development: An analysis of IDRC-supported projects. *The Electronic Journal of Information Systems*

Rodrigues, M., and Rodríguez, A. 2013. Information and communication technologies for agricultural development in Latin America: trends, barriers and policies.

Ruhangawebare, G. 2010. Factors affecting the level of commercialization among cattle keepers in the pastoral areas of Uganda.

Sen, S., and Choudhary, V. 2009. ICT APPLICATIONS FOR SMALLHOLDER INCLUSION IN AGRIBUSINESS SUPPLY CHAINS, (Gelhar), 239–258.

Shadrach, B., and Summers, R. 2002. Appropriate Evaluation Methods for ICT Initiatives, *12*(1), 1–12.

Shepherd, A. W. 2007. Approaches to linking producers to markets.

Sikawa, B. G. Y., and Mugisha, J. 2011. Factors influencing south-western uganda dairy farmers' choice of the milk marketing channel: a case study of kirihura district- south western uganda., *I*.

Siraj, M. n.d.. A model for ICT based services for agriculture extension in Pakistan.

Sylvester, G. 2013. Technologies for agricultural information sharing - Part II, 51–105.

TechnoServe Kenya. 2008. *The Dairy Value Chain in Kenya*.

The World Bank. 2011. *Uganda Dairy Supply Chain Risk Assessment*.

Tiwari, M., Chakravarty, R., and Goyal, J. 2014. Availability and Accessibility of Information Communication Technology (ICT) among dairy farmers in Uttarakhand, India, *2*(7), 47–52.

Uganda Bureau of Statistics (UBOS). 2014. *Uganda Bureau of Statistics statistical abstract.*

Uganda Communications Commission (UCC). 2009. *Rcdf policy 2010/11 – 2014/15*.

United Nations Development Programme (UNDP). 2007. Uganda Human Development Report - Rediscovering Agriculture for Human Development. *Human Development*, (August 2005), 136.

United States Agency for International Development (USAID). 2013. Uganda Mobile Money Assessment and Case Study Examining Cash Payment Streams and Uganda Mobile Money Study. *United States Agency for International Development.*, (February), 1–71.

Venkatesh, V. 2012. Consumer Acceptance and Use of Information Technology, *36*(1), 157–178.

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. 2003. User Acceptance of Information Technology : Toward a Unified View. Published by : Management Information Systems Research Center , University of Minnesota. *MIS Quarterly*, *27*(3), 425–478.

Venkatesh, V. http://www.vvenkatesh.com. Accessed on July 15, 2015.

World Bank. 2011a. *Connecting Smallholders to ICT in Agriculture: Connecting Smallholders to Knowledge , Networks*.

World Bank. 2011b. ICT In Agriculture: Connecting Smallholders to ICT IN AGRICULTURE Connecting Smallholders to Knowledge , Networks , (64605).

World Bank. 2011c. ICT in agriculture: connecting smallholders to knowledge, networks, and institutions. *World*, (64605), 424.

Wozemba, D., and Nsanja, R. 2008. Dairy Investment Opportunities in Uganda- Report. *Dairy Investment Opportunity Uganda*, *1*(1), 1–56.

Wozemba, D., and Rashid, N. 2008. Dairy investment opportunities in Uganda-report. *SNV Report*.

7. APPENDICES

Appendix Table 1: VIF values for the independent variables

VARIABLE	VIF	1/VIF
SKILL	3.15	0.317057
USEFULNESS	2.47	0.404755
ACCESSIBIL~Y	2.61	0.382427
AFFORDABIL~Y	2.33	0.428433
INFOSEEK	1.83	0.545345
JOBPERF	3.84	0.260203
EASE	3.03	0.329518
IMPORTANCE	1.33	0.751911
INFRASTRUC~E	1.54	0.650877
TIMELY_INFO	1.38	0.724129
AGE_GP		
2	2.59	0.385605
3	3.05	0.327550
MSTATUS	2.47	0.404616
GENDER	1.19	0.839439
LEVEL		
1	3.31	0.301847
2	4.60	0.217265
3	2.61	0.383752
4	4.35	0.230043
FSIZE	2.85	0.350494
OCCUPATION		
2	1.43	0.701041
3	1.85	0.540612
4	1.35	0.739585
5	1.30	0.767939
6	1.92	0.520481
7	1.76	0.568133
8	1.42	0.702606

9	1.32	0.758111
EXPERIENCE		
2	1.72	0.583033
3	1.84	0.542134
DISTANCE		
2	1.42	0.706526
3	1.48	0.677344
4	1.28	0.783419
MEAN VIF	2.21	

Appendix Table 2. VIF values for interval variables

Collinearity Statistics	
Tolerance	VIF
.686	1.458
.906	1.103
.358	2.790
.352	2.840
.652	1.534
.494	2.026
.583	1.716
.397	2.518
.565	1.771

Appendix Table 3. Contingency Coefficient matrix for categorical variables

	age	gender	Marital status	Infrastructure	Level of education	Information Timeliness	occupation	Experience	Distance from Collection center
Age	1	0.123	0.561	0.199	0.332	0.230	0.361	0.301	0.292
Gender		1	0.001	0.251	0.091	0.209	0.228	0.075	0.056
Marital status			1	0.144	0.222	0.157	0.183	0.340	0.164
Infrastructure				1	0.274	0.442	0.374	0.201	0.135
Level of education					1	0.366	0.509	0.235	0.281
Information Timeliness						1	0.466	0.168	0.252
Occupation							1	0.443	0.390
Experience								1	0.230
Distance from Collection center									1

Appendix 4: Interview Schedule

School of Graduate Studies, Haramaya University

Interview Schedule

"An assessment of the extent of ICT use along the dairy value chain in Western Uganda".

My name is Samuel Otaala, a Master's student from Haramaya University, Ethiopia. I am currently doing a research on assessing the extent of the use of ICT along the dairy value chain in your area. I am therefore kindly requesting you to answer these questions as an actor in the dairy value chain in the study area.

Name of interviewer……

Date of Interview……

Contact of Interviewer……

PART I

Demographic Data

1. Name of Respondent……
2. Age Group of respondent: Below 35 ☐ 35-59 ☐ above 60 ☐
3. Gender……
4. Marital Status……..
5. Have you attended any formal education? (a) Yes ☐ (b) No ☐

6. If yes, which level?
   a) Primary ☐
   b) Secondary ☐
   c) Tertiary ☐
   d) University ☐
7. What is your family size? .....

PART II

8. What is your occupation? ☐ Farmer, ☐ Truck transporter, ☐ other transporter, ☐ bulk collection center, ☐ processing plant, ☐ Informal retailer, ☐ formal retailer (shops), ☐ dairy cooperative.
9. How many years of experience do you have in your occupation? ☐ 0-5 years, ☐ 5-10 years, ☐ 10 years and above.
10. How far is your home from the collection center? ☐ 30 minutes or less, ☐ 30 minutes to 1 hour, ☐ 1 hour to 2 hours, ☐ more than 2 hours
11. How many dairy cows do you possess?
12. Do you have access to the following ICTs?

Type of ICT	Yes	No	Access (1=no access, 2=low access, 3=medium access, 4=high access, 5=ownership)
Radio			
Television			
Mobile Phone			
Computer			

13. How would you gauge yourself in the use of the following ICTs?

Type of ICT	Low Skills	Medium Skills	High Skills

	(Very few functions)	(Many of the common functions)	(Most of the functions of the ICT)
Radio			
Television			
Mobile Phone			
Computer			

14. What is the type of information you mostly get from the ICTs?

Type of ICT	Types of information (1=Extension Services, 2=Quality Control, 3=Financial Services, 4=Logistics, 5=Business process, 6=Data Collection)
Radio	
Television	
Mobile Phone	
Computer	

15. How frequently do you get market access from the ICT?

Type of ICT	Yes	No	Frequency of use (1=daily, 2=weekly, 3=monthly, 4=Occasionally, 5=very rarely)
Radio			
Television			
Mobile Phone			
Computer			

16. What kind of information flows do you use the ICTs for?

Type of information flow	ICTs Used (1=Radio, 2=TV, 3=Mobile Phone, 4=Computer)
Coordination of Milk Products distribution	
Knowledge and Experience sharing among colleagues	
Feedback between producers and	

consumers	

17. How useful are the ICTs to your business?

Type of ICT	Not Useful=1	Somewhat Useful=2	Moderately Useful=3	Useful=4	Very Useful=5
Radio					
Television					
Mobile Phone					
Computer					

18. How many companies/ organisations do you get information from?.....
19. Is this information paid for? (a) Yes ☐ (b) No ☐
20. If yes, how much do you pay per information received? …….....Shillings.
21. In What form do you obtain the information?

a) SMS ☐	d) Radio Broadcast ☐
b) Voice calls ☐	e) TV Broadcast ☐
c) Smart phone application ☐	f) Others (Specify) ☐
	……
	…….....

22. Which form would you prefer the information be given in?

a) SMS ☐	d) Radio Broadcast ☐

b) Voice calls ☐ c) Smart phone application ☐	e) TV Broadcast ☐ f) Others (Specify) ☐ …… ……

23. Why do you prefer that form of information?

……

……

……..

24. Does the information come at the right time when you need them?

(a) Yes ☐ (b) No ☐

25. Can you rely on this information? (a) Yes ☐ (b) No ☐
26. If No, which other sources do you get information from?
27. Has your business improved due to this information?
(a) Yes ☐ (b) No ☐
28. Do you think that there is enough infrastructure to help you to use the ICTs (Radio, TV, Mobile Phone, Computer)? (a) Yes ☐ (b) No ☐
29. Do you think that it is important in this community to have any of the ICTs (Radio, TV, Mobile Phone, Computer)?
30. Do you think it is easy to use the ICT well? Radio? ☐ TV? ☐ Mobile Phoone? ☐ Computer? ☐
31. Will the ICT improve your performance in your job? Radio? ☐ TV? ☐ Mobile Phoone? ☐ Computer? ☐

32. Do you actively seek information from the ICT? Radio? ☐ TV? ☐ Mobile Phoone? ☐ Computer? ☐
33. Do you think the ICT is affordable? Radio? ☐ TV? ☐ Mobile Phoone? ☐ Computer? ☐

PART III

34. What challenges do you face while using the information provided?

……
……
……
……

35. What do you think should be done differently to improve the information services?

……
……
……
……**Thank you**

Appendix 5: Guide of focus group discussion and Key Informant Interviews

1. Which of ICT do you own?(TV, Radio, Computer, Mobile Phone)
2. Which ICT do you have access to?
3. What is the type of information mostly got from: TV, Radio, Computer, Mobile Phone
4. How often do you get agricultural information from your ICT?
5. How often do you get market information from your ICT?
6. What do you mostly use the mobile phone and radio for?
7. How many companies do you get information from?
8. How useful are the ICTs to your business?
9. What form do you prefer your information? SMS, Voice, App, Radio, TV, or other.
10. Do you find your information services reliable?
11. What challenges do you face in using your ICTs?
12. What do you think should be done differently to improve information services?